Science, Service, Stewardship

2022 5-Year Review: Summary & Evaluation of **Middle Columbia River Steelhead**

National Marine Fisheries Service
West Coast Region

5-Year Review: Middle Columbia River Species

Species Reviewed	Distinct Population Segment
Steelhead (*Oncorhynchus mykiss*)	*Middle Columbia River Steelhead*

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1. General Information

1.1 Introduction

Many West Coast salmon and steelhead (*Oncorhynchus spp.*) stocks have declined substantially from their historic numbers and now are at a fraction of their historical abundance. There are several factors that contribute to these declines, including: overfishing, loss of freshwater and estuarine habitat, hydropower development, poor ocean conditions, and hatchery practices. These factors collectively led to the National Marine Fisheries Service's (NMFS) listing of 28 salmon and steelhead stocks in California, Idaho, Oregon, and Washington under the Federal Endangered Species Act (ESA).

The ESA, under section 4(c)(2), directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every five years. A 5-year review is a periodic analysis of a species' status conducted to ensure that the listing classification of a species as threatened or endangered on the List of Endangered and Threatened Wildlife and Plants (List) (50 CFR 17.11–17.12; 50 CFR 223.102, 224.101) is accurate (USFWS and NMFS 2006; NMFS 2020a). After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from endangered to threatened; or (3) have its status changed from threatened to endangered. If, in the 5-year review, a change in classification is recommended, the recommended change will be further considered in a separate rule-making process. The most recent 5-year review analysis for West Coast salmon and steelhead occurred in 2016. This document describes the results of the 2022 5-year review for ESA-listed Middle Columbia River (MCR) steelhead.

A 5-year review is:

- A summary and analysis of available information on a given species;
- The tracking of a species' progress toward recovery;
- The recording of the deliberative process used to make a recommendation on whether or not to reclassify a species; and
- A recommendation on whether reclassification of the species is indicated.

A 5-year review is not:

- A re-listing or justification of the original (or any subsequent) listing action;
- A process that requires acceleration of ongoing or planned surveys, research, or modeling;
- A petition process; and
- A rulemaking.

1.1.1 Background on salmonid listing determinations

The ESA defines species to include subspecies and distinct population segments (DPSs) of vertebrate species. A species may be listed as threatened or endangered. To identify taxonomically recognized species of Pacific salmon we apply the Policy on Applying the Definition of Species under the ESA to Pacific Salmon (56 FR 58612). Under this policy, we identify population groups that are evolutionarily significant units (ESUs) within taxonomically recognized species. We consider a group of populations to be an ESU if it is substantially reproductively isolated from other populations within the taxonomically recognized species and represents an important component in the evolutionary legacy of the species. We consider an ESU as constituting a DPS and therefore a species under the ESA.

Under the DPS policy, a DPS of steelhead must be discrete from other populations, and it must be significant to its taxon.

Artificial propagation programs (hatcheries) are common throughout the range of ESA-listed West Coast salmon and steelhead. Prior to 2005, our policy was to include in the listed ESU or DPS only those hatchery fish deemed essential for conservation of a species. We revised that approach in response to a court decision and on June 28, 2005, announced a final policy addressing the role of artificially propagated Pacific salmon and steelhead in listing determinations under the ESA (70 FR 37204) (Hatchery Listing Policy). This policy establishes criteria for including hatchery stocks in ESUs and DPSs. In addition, it: (1) provides direction for considering hatchery fish in extinction risk assessments of ESUs and DPSs; (2) requires that hatchery fish determined to be part of an ESU or DPS be included in any listing of the ESU or DPS; (3) affirms our commitment to conserving natural salmon and steelhead populations and the ecosystems upon which they depend; and (4) affirms our commitment to fulfilling trust and treaty obligations with regard to the harvest of some Pacific salmon and steelhead populations, consistent with the conservation and recovery of listed salmon ESUs and steelhead DPSs.

To determine whether a hatchery program is part of an ESU or DPS, and therefore must be included in the listing, we consider the origins of the hatchery stock, where the hatchery fish are released, and the extent to which the hatchery stock has diverged genetically from the donor stock. We include within the ESU or DPS (and therefore within the listing) hatchery fish that are no more than moderately diverged from the local population.

Because the new Hatchery Listing Policy changed the way we considered hatchery fish in ESA listing determinations, we completed new status reviews and ESA listing determinations for West Coast salmon ESUs on June 28, 2005 (70 FR 37159), and for steelhead DPSs on January 5, 2006 (71 FR 834). On August 15, 2011, we published our 5-year reviews and listing determinations for 11 ESUs of Pacific salmon and 6 DPSs of steelhead from the Pacific Northwest (76 FR 50448). On May 26, 2016, we published our 5-year reviews and listing determinations for 17 ESUs of Pacific salmon, 10 DPSs of steelhead, and the southern DPS of eulachon (*Thaleichthys pacificus*) (81 FR 33468), including reaffirming threatened status for MCR steelhead.

1.2 Methodology used to complete the review

On October 4, 2019, we announced the initiation of 5-year reviews for 17 ESUs of salmon and 11 DPSs of steelhead in Oregon, California, Idaho, and Washington (84 FR 53117). We requested that the public submit new information on these species that has become available since our 2015-2016 5-year reviews. In response to our request, we received information from Federal and state agencies, Native American Tribes, conservation groups, fishing groups, and individuals. We considered this information, as well as information routinely collected by our agency, to complete these 5-year reviews.

To complete the reviews, we first asked scientists from our Northwest and Southwest Fisheries Science Centers to collect and analyze new information about ESU and DPS viability. To evaluate viability, our scientists used the Viable Salmonid Population (VSP) concept developed by McElhany et al. (2000). The VSP concept evaluates four criteria – abundance, productivity, spatial structure, and diversity – to assess species viability. Through the application of this concept, the science centers considered new information for a given ESU or DPS relative to the four salmon and steelhead population viability criteria. They also considered new information on ESU and DPS delineations. At the end of this process, the science teams prepared reports detailing the results of their analyses (Ford 2022).

To further inform the reviews, we also asked our Northwest salmon management biologists familiar with hatchery programs to consider new information available since the previous listing determinations. Among other things, they considered hatchery programs that have ended, new hatchery programs that have started, changes in the operation of existing programs, and scientific data relevant to the degree of divergence of hatchery fish from naturally spawning fish in the same area. We consulted our Northwest biologists and other salmon management specialists familiar with hatchery programs, habitat conditions, hydropower operations, and harvest management. In a series of structured meetings, by geographic area, these biologists identified relevant information and provided their insights on the degree to which circumstances have changed for each listed entity. Finally, we solicited information on tributary habitat conditions and limiting factors from geographically-based salmon conservation partners from Federal agencies, state agencies, Tribes, and non-governmental organizations.

In preparing this report, we considered all relevant information, including the work of the Northwest Fisheries Science Center Ford 2022; the report of the regional biologists regarding hatchery programs; recovery plans for the species in question; technical reports prepared in support of recovery plans for the species in question; the listing record (including designation of critical habitat and adoption of protective regulations); recent biological opinions issued for MCR steelhead; information submitted by the public and other government agencies; and the information and views provided by geographically based salmon conservation partners. The present report describes the agency's findings based on all of the information considered.

1.3 Background – Summary of Previous Reviews, Statutory and Regulatory Actions, and Recovery Planning

1.3.1 Federal Register Notice announcing initiation of this review

84 FR 53117; October 4, 2019.

1.3.2 Listing history

In 1999, NMFS listed MCR steelhead under the ESA and classified it as a threatened species (Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for the MCR Steelhead DPS.

Salmonid Species	ESU/DPS Name	Original Listing	Revised Listing(s)
Steelhead (*O. mykiss*)	Middle Columbia River Steelhead	**FR Notice:** 64 FR 14517 **Date:** 3/25/1999 **Classification:** Threatened	**FR Notice:** 71 FR 834 **Date:** 1/5/2006 **Re-classification:** Threatened

1.3.3 Associated rulemakings

The ESA requires NMFS to designate critical habitat, to the maximum extent prudent and determinable, for species it lists under the ESA. Critical habitat is defined as: (1) specific areas within the geographical area occupied by the species at the time it is listed, on which are found those physical or biological features essential to the conservation of the species, and which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination by the Secretary that such areas are essential for the conservation of the species. We designated critical habitat for MCR steelhead in 2005.

Section 9 of the ESA prohibits the take of species listed as endangered. The ESA defines take to mean harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. For threatened species, the ESA does not automatically prohibit take, but instead authorizes the agency to adopt regulations it deems necessary and advisable for species conservation and to apply the take prohibitions of section 9(a)(1) through ESA section 4(d). In 2000, NMFS adopted 4(d) regulations for threatened salmonids that prohibit take except in specific circumstances. In 2005, we revised our 4(d) regulations for consistency between ESUs and DPSs, and, to take into account our Hatchery Listing Policy.

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for the MCR Steelhead.

Salmonid Species	ESU/DPS Name	4(d) Protective Regulations	Critical Habitat Designations
Steelhead (*O. mykiss*)	Middle Columbia River Steelhead	**FR notice:** 65 FR 42422 **Date:** 7/10/2000 **Revised:** 6/28/2005 (70 FR 37159)	**FR notice:** 70 FR 52630 **Date**: 9/2/2005

1.3.4 Review History

Table 3 lists the numerous scientific assessments of the status of the MCR steelhead DPS. These assessments include status reviews conducted by our Northwest Fisheries Science Center and technical reports prepared in support of recovery planning for this DPS.

Table 3. Summary of previous scientific assessments for the MCR Steelhead.

Salmonid Species	ESU/DPS Name	Document Citation
Steelhead (*O. mykiss*)	Middle Columbia River Steelhead	Ford 2022 NMFS 2016a NWFSC 2015 Ford et al. 2011 ICTRT and Zabel 2007 ICTRT 2007a ICTRT 2007b McClure et al. 2005 Good et al. 2005 ICTRT 2003 Busby et al. 1996 NMFS 1997 NMFS 1999a NMFS 1999b

1.3.5 Species' Recovery Priority Number at Start of 5-year Review Process

On April 30, 2019, NMFS issued new guidelines (84 FR 18243) for assigning listing and recovery priorities. For determining a recovery priority for recovery plan development and implementation, we assess demographic risk (based on the listing status and species' condition in terms of its productivity, spatial distribution, diversity, abundance, and trends) and recovery potential (major threats understood, management actions exist under U.S. authority or influence to abate major threats, and certainty that actions will be effective) to assign a Recovery Priority number from 1 (high) to 11 (low). Additionally, if the listed species is in conflict with construction or other development projects or other forms of economic activity, then they are assigned a ‘C’ and are given a higher priority over those species that are not in conflict. Table 4 lists the recovery priority number for the MCR steelhead DPS that was in effect at the time this 5-year review began (NMFS 2019a). In January 2022, NMFS issued a new report with updated recovery priority numbers. The number for MCR steelhead was revised to 3C (NMFS 2022).

1.3.6 Recovery Plan or Outline

Table 4. Recovery Priority Number (NMFS 2019a) and Endangered Species Act Recovery Plan for the MCR Steelhead.

Salmonid Species	ESU/DPS Name	Recovery Priority Number	Recovery Plans/Outline
Steelhead (*O. mykiss*)	Middle Columbia River Steelhead	5C	**Title:** Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan Available at: https://www.fisheries.noaa.gov/resource/document/recovery-plan-middle-columbia-river-steelhead-distinct-population-segment **Date:** 2009 **Type:** Final **FR Notice:** 74 FR 50165

2. Review Analysis

In this section we review new information to determine whether the MCR steelhead DPS delineation remains appropriate.

2.1 Delineation of species under the Endangered Species Act

Is the species under review a vertebrate?

DPS Name	YES	NO
Middle Columbia River Steelhead	X	

Is the species under review listed as a DPS?

DPS Name	YES	NO
Middle Columbia River Steelhead	X	

Was the DPS listed prior to 1996?

DPS Name	YES	NO	Date Listed if Prior to 1996
Middle Columbia River Steelhead		X	n/a

Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 DPS policy standards?

In 1991, NMFS issued a policy explaining how the agency would delineate DPSs of Pacific salmon for listing consideration under the Endangered Species Act (ESA) (56 FR 58612). Under this policy a group of Pacific salmon populations is considered a "species" under the ESA if it represents an "evolutionarily significant unit" (ESU), which meets the two criteria of: (1) being substantially reproductively isolated from other con-specific populations; and (2) representing an important component in the evolutionary legacy of the biological species. The 1996 joint NMFS-Fish and Wildlife Service (FWS) Distinct Population Segment (DPS) policy (61 FR 4722) affirmed that a stock (or stocks) of Pacific salmon is considered a DPS if it represents an ESU of a biological species. Accordingly, in listing the MCR steelhead DPS under the DPS policy in 1999, we used the joint DPS policy to delineate the DPS under the ESA.

2.1.1 Summary of relevant new information regarding delineation of the MCR steelhead DPS

DPS Delineation

This section provides a summary of information presented in Ford 2022: *Biological viability assessment update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest*.

We found no new information that would justify a change in the delineation of the MCR steelhead DPS (Ford 2022).

Membership of Hatchery Programs

For West Coast salmon and steelhead, many of the ESU and DPS descriptions include fish originating from specific artificial propagation programs (*e.g.,* hatcheries) that, along with their naturally-produced counterparts, are included as part of the listed species. NMFS' Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead (Hatchery Listing Policy) (70 FR 37204) guides our analysis of whether individual hatchery programs should be included as part of the listed species. The Hatchery Listing Policy states that hatchery programs will be considered part of an ESU/DPS if they exhibit a level of genetic divergence relative to the local natural population(s) that is not more than what occurs within the ESU/DPS.

In preparing this report, our hatchery management biologists reviewed the best available information regarding hatchery membership of this ESU and DPS. They considered changes in hatchery programs that occurred since the last 5-year review (e.g., some have been terminated while others are new) and made recommendations about the inclusion or exclusion of specific programs. They also noted any errors and omissions in the existing descriptions of hatchery program membership. NMFS intends to address any needed changes and corrections via separate rulemaking subsequent to the completion of the 5-year review process prior to any official change in hatchery membership.

At the time of the 2016 5-year review, the MCR steelhead DPS was defined as including naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Wind and Hood Rivers (exclusive) to and including the Yakima River; it excludes such fish originating from the Snake River basin. This DPS includes steelhead from the following artificial propagation programs: the Touchet River Endemic Program; Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River); Umatilla River Program (Oregon Department of Fish and Wildlife (ODFW) Stock #91); and the Deschutes River Program (ODFW Stock #66). This DPS does not include steelhead that are designated as part of an experimental population (71 FR 834).

Since 2016, we updated the names of two programs that are included in the DPS, from the Deschutes River Program (ODFW Stock #66) to the Deschutes River Program; and from the Umatilla River Program (ODFW Stock #91) to the Umatilla River Program (85 FR 81822).

Kelts are adult steelhead that have completed spawning and are migrating downstream to the ocean, where, if they survive, can return to spawn again (i.e., repeat spawners). However, kelts from basins above multiple mainstem dams do not survive at high rates to become repeat spawners due to poor out-migration past the dams. The kelt reconditioning programs collect these post-spawning adult steelhead, as they migrate from the spawning grounds, and then hold and feed them for a number of months before releasing them back into their natal river to spawn. The Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), should be removed from inclusion in the DPS because the kelt reconditioning program is not considered a hatchery program compared to the other programs that are included in the DPS. The removal of the Yakima River Kelt Reconditioning program would be consistent with the non-inclusion of other kelt reconditioning programs in other DPSs.

The addition or removal of an artificial propagation program from an ESU/DPS does not necessarily affect the listing status of the ESU/DPS, but is a revision to the ESU's/DPS's composition to reflect the best available scientific information as considered under our Hatchery Listing Policy. Addition of an artificial propagation program to an ESU/DPS represents our determination that the artificially propagated stock is no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU (70 FR 37204). We reaffirm the Hatchery Listing Policy in our 2020 Final Rule on Revisions to Hatchery Programs as Part of Pacific Salmon and Steelhead Species Listed under the Endangered Species Act (85 FR 81822).

2.2 Recovery Criteria

The ESA requires NMFS to develop recovery plans for each listed species. Recovery plans must contain, to the maximum extent practicable, objective measurable criteria for delisting the species, site-specific management actions necessary to recover the species, and time and cost estimates for implementing the recovery plan.

Evaluating a species for potential changes in ESA listing requires an explicit analysis of population or demographic parameters (the biological criteria) and also of threats under the five ESA listing factors in ESA section 4(a)(1) (listing factor [threats] criteria). Together these make up the objective, measurable criteria required under section 4(f)(1)(B).

For Pacific salmon, Technical Recovery Teams (TRTs), appointed by NMFS, define criteria to assess biological viability for each listed species. NMFS develops criteria to assess progress toward alleviating the relevant threats (listing factor criteria).

NMFS adopts the TRT's viability criteria as the biological criteria for a recovery plan, based on best available scientific information and other considerations as appropriate. For the Middle

Columbia River steelhead DPS, the recovery plan consists of a DPS-wide plan (NMFS 2009) and associated geographic management unit plans (Klickitat: NMFS 2009; Oregon: Carmichael and Taylor 2010; Rock Creek: NMFS 2009; SE Washington: SRSRB 2011; White Salmon River: NMFS 2013; and Yakima Basin: YBFWRB 2009). In those plans, NMFS adopted the viability criteria metrics defined by the Interior Columbia Technical Recovery Team (ICTRT 2007b) as the biological recovery criteria for the DPS.

As the recovery plan is implemented, additional information becomes available along with new scientific analyses that can increase certainty about whether the threats have been abated, whether improvements in population biological viability have occurred for MCR steelhead, and whether linkages between threats and changes in salmon biological viability are understood. NMFS assesses progress toward meeting the recovery criteria during the ESA 5-Year Review (USFWS and NMFS 2006; NMFS 2020b).

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

DPS Name	YES	NO
Middle Columbia River Steelhead	X	

2.2.2 Adequacy of recovery criteria

Based on new information considered during this review, are the recovery criteria still appropriate?

DPS Name	YES	NO
Middle Columbia River Steelhead	X	

Are all of the listing factors that are relevant to the species addressed in the recovery criteria?

DPS Name	YES	NO
Middle Columbia River Steelhead	X	

2.2.3 List the biological recovery criteria as they appear in the recovery plan

For the purposes of reproduction, salmon and steelhead typically exhibit a metapopulation structure (McElhany et al. 2000; Schtickzelle and Quinn 2007). Rather than interbreeding as one large aggregation, ESUs and DPSs function as a group of demographically independent populations separated by areas of unsuitable spawning habitat. For conservation and management purposes, it is important to identify the independent populations that make up an ESU or DPS.

McElhany et al. (2000) defined an independent population as: "…a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season." For our purposes, not interbreeding to a "substantial degree" means that two groups are considered to be independent populations if they are isolated to such an extent that exchanges of individuals among the populations do not substantially affect the population dynamics or extinction risk of the independent populations over a 100-year time frame. Independent populations exhibit different population attributes that influence their abundance, productivity, spatial structure and diversity. Independent populations are the units that are combined to form alternative recovery scenarios for multiple similar population groupings and ESU/DPS viability.

The viable salmonid population (VSP) concept (McElhany et al. 2000) is based on the biological parameters of abundance, productivity, spatial structure, and diversity for an independent salmonid population to have a negligible risk of extinction over a 100-year time frame. The VSP concept identifies the attributes, provides guidance for determining the conservation status of populations and larger-scale groupings of Pacific salmonids, and describes a general framework for how many and which populations within an ESU/DPS should be at a particular status for the ESU/DPS to have an acceptably low risk of extinction. McElhany et al. (2000) developed combined VSP criteria metrics that describe the probability of population extinction risk in 100 years (Figure 1). NMFS color coded the risk assessment to assist the readers more easily distinguish the various risk categories.

		VSP Criteria Metrics			
		Spatial Structure/Diversity Risk			
		Very Low	Low	Moderate	High
Abundance/ Productivity Risk	Very Low (<1%)	Very Low Risk (Highly Viable)	Very Low Risk (Highly Viable)	Low Risk (Viable)	Moderate Risk
	Low (<5%)	Low Risk (Viable)	Low Risk (Viable)	Low Risk (Viable)	Moderate Risk
	Moderate (<25%)	Moderate Risk	Moderate Risk	Moderate Risk	High Risk
	High (>25%)	High Risk	High Risk	High Risk	High Risk

Figure 1. VSP Criteria Metrics.

For the purposes of recovery planning and the development of recovery criteria, the NMFS-appointed Interior Columbia Technical Recovery Team (ICTRT) identified independent populations for MCR steelhead, and then grouped them together into genetically similar major population groups (MPGs) (ICTRT 2003).

The ICTRT also developed species biological viability criteria for applications at the ESU/DPS, MPG and independent population scales (ICTRT 2007b). The viability criteria are based on the VSP concept described above. Recovery scenarios outlined in the ICTRT viability criteria report (ICTRT 2007b) are targeted to achieve, at a minimum, the ICTRT's biological viability criteria for each major population grouping. Accordingly, the criteria are designed "[t]o have all major population groups at viable (low risk) status with representation of all the major life history strategies present historically, and with the abundance, productivity, spatial structure, and diversity attributes required for long-term persistence." Recovery criteria and strategies outlined in the MCR Steelhead Recovery Plan are targeted on achieving, at a minimum, the ICTRT biological viability criteria for each major population grouping in the DPS.

The MCR steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Wind and Hood Rivers (exclusive) to and including the Yakima River; and excludes such fish originating from the Snake River basin. This DPS does include steelhead from four artificial propagation programs: the Touchet River Endemic Program; Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River); Umatilla River Program; and the Deschutes River Program. This DPS does not include steelhead that are designated as part of an experimental population (79 FR 20802; Figure 2). For recovery planning and development of recovery criteria, the Interior Columbia Technical Recovery Team (ICTRT) identified independent populations within the MCR steelhead DPS and grouped them into genetically similar major population groups (MPGs) (ICTRT 2003). The DPS is composed of four MPGs: Cascades Eastern Slope Tributaries, John Day River, Yakima River, and Walla Walla and Umatilla Rivers.

Recovery strategies outlined in the 2009 Mid-Columbia Recovery Plan and its management unit components are targeted on achieving, at a minimum, the ICTRT biological viability criteria for each major population grouping in the DPS "... to have all four major population groups at viable (low risk) status with representation of all the major life history strategies present historically, and with the abundance, productivity spatial structure, and diversity attributes required for long-term persistence." The plan recognizes that, at the major population group level, there may be several specific combinations of populations that could satisfy the ICTRT criteria. Each of the management unit plans identifies particular combinations that are the most likely to result in achieving viable major population group status. The recovery plan recognizes that the management unit plans incorporate a range of objectives that go beyond the minimum biological status required for delisting (NMFS 2009).

The ICTRT recovery criteria are hierarchical in nature, with DPS level criteria being based on the status of natural-origin steelhead assessed at the population level.

Under the ICTRT approach, population level assessments are based on a set of metrics designed to evaluate risk across the four viable salmonid population elements: A/P, spatial structure, and diversity (McElhany et al. 2000). The ICTRT approach calls for comparing estimates of current natural-origin abundance (measured as a 10-year geometric mean of natural-origin spawners) and productivity (estimate of return per spawner at low to moderate parent spawning abundance) against predefined viability curves. In addition, the ICTRT developed a set of specific criteria (metrics and example risk thresholds) for assessing the spatial structure and diversity risks based on current information representing each specific population. The ICTRT viability criteria are generally expressed relative to a particular risk threshold – 5 percent risk of extinction over a 100-year period.

The Mid-Columbia Recovery Plan identifies a set of most likely scenarios to meet the ICTRT recommendations for low risk populations at the MPG level. In addition, the management unit plans generally call for achieving moderate risk ratings (maintained status) across the remaining extant populations in each MPG (NMFS 2009). The following describes the combination of population status most likely to achieve viability for each MPG.

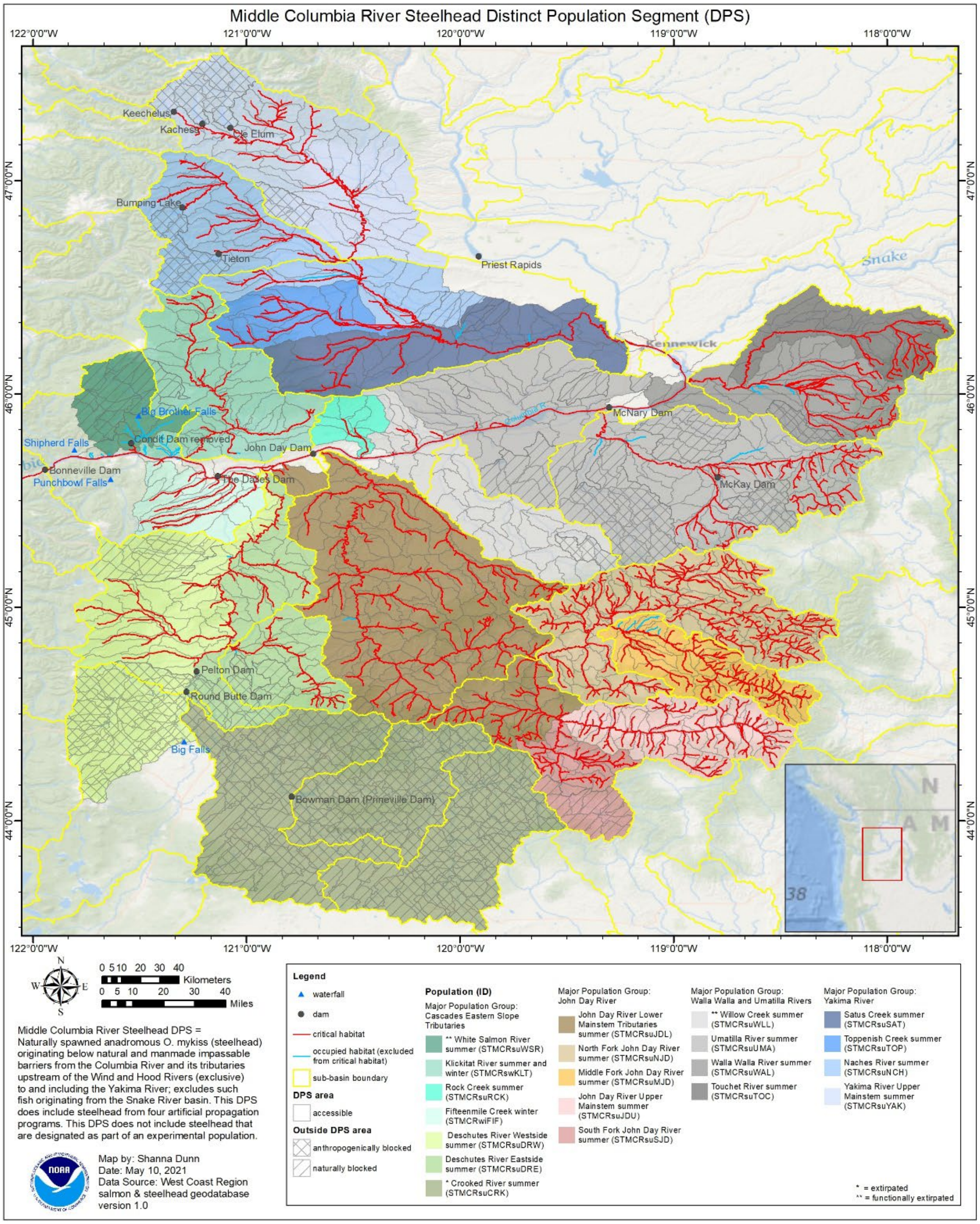

Figure 2. MCR Steelhead population structure[1]

[1] The map above generally shows the accessible and historically accessible areas for the MCR steelhead. The area displayed is consistent with the regulatory description of the composition of the MCR steelhead found at 50 CFR17.11, 223.102, and 224.102. Actions outside the delineations shown can affect this DPS. Therefore, these delineations do not delimit the entire area that could warrant consideration in recovery planning or determining if an action may affect this DPS for the purposes of the ESA.

Cascades Eastern Slope Tributaries MPG

The Klickitat River, Fifteenmile Creek, and both the Deschutes River Eastside and Deschutes River Westside populations should reach at least viable status. The management unit plans also call for at least one population to be highly viable, consistent with ICTRT recommendations. The Rock Creek population should reach maintained status (25 percent or less risk level). MPG viability could be further bolstered if reintroduction of steelhead into the Crooked River succeeds and if the White Salmon River population successfully recolonizes its historical habitat following the removal of Condit Dam.

John Day River MPG

The John Day River Lower Mainstem Tributaries, North Fork John Day River and either the Middle Fork John Day River or John Day River Upper Mainstem populations should achieve at least viable status. The management unit plan also calls for at least one population to be highly viable, consistent with ICTRT recommendations.

Yakima River MPG

To achieve viable status, two populations should be rated as viable, including at least one of the two, classified as large – the Naches River and the Yakima River Upper Mainstem. The remaining two populations should, at a minimum, meet the maintained criteria. The management unit plan also calls for at least one population to be highly viable, consistent with ICTRT recommendations.

Umatilla/Walla Walla Rivers MPG

Two populations should meet viability criteria. The management unit plan also calls for at least one population to be highly viable, consistent with ICTRT recommendations. The Umatilla River is the only large population, and therefore needs to be viable. In addition, either the Walla Walla River or Touchet River also needs to be viable.

2.3 Updated Information and Current Species' Status

Information provided in this section includes a summary from Biological viability assessment update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest (Ford 2022) (Subsection 2.3.1), and our current listing factors analysis (Subsection 2.3.2).

2.3.1 Analysis of VSP Criteria (including discussion of whether the VSP criteria have been met)

Updated Biological Risk Summary

There has been functionally no change in the viability ratings for the component populations, and the MCR steelhead DPS does not currently meet the viability criteria described in the Middle Columbia River Steelhead Recovery Plan (NMFS 2009). In addition, several of the factors cited by the 2005 BRT remain as concerns or key uncertainties. While recent (5-yr) returns are declining across all populations, the declines are from relatively high returns in the previous 5-10 year interval, so the longer-term risk metrics that are meant to buffer against short-period changes in abundance and productivity remain unchanged. Natural-origin spawning estimates are highly variable relative to minimum abundance thresholds across the populations in the DPS. Two of the four MPGs in this DPS include at least one population rated at “low” or “very low” risk for abundance and productivity, while the other two MPGs remain in the “moderate” to “high” risk range (Figures 3-6). Updated information indicates that stray levels into the John Day River populations have decreased in recent years. Out-of-basin hatchery stray proportions, although reduced, remain high in spawning reaches within the Deschutes River basin and the Umatilla, Walla Walla, and Touchet River populations. Overall, the Middle Columbia River steelhead DPS remains at “moderate” risk of extinction, with viability unchanged from the prior review (Ford 2022).

		Risk Rating for Spatial Structure and Diversity			
		Very Low	Low	Moderate	High
Risk Rating for Abundance/Productivity	Very Low (<1%)				
	Low (1–5%)				
	Moderate (6–25%)		***Fifteenmile Cr.***	***Klickitat R. Deschutes R.-Eastside***	
	High (>25%)			***Deschutes R.-Westside Rock Cr.***	

Figure 3. Cascades Eastern Slope Tributaries MPG population risk ratings integrated across the four VSP parameters. Viability key: dark green – highly viable; light green – viable; orange – maintained; and red – high risk (does not meet viability criteria) (Ford 2022, Table 27, p. 110).

The Cascades Eastern Slope Tributaries MPG is not viable. The Cascades Eastern Slope Tributaries MPG does not meet the recovery viability criteria of the Klickitat, Fifteenmile, and both the Deschutes Eastside and Westside populations achieving viable status (low risk), with one highly viable population, and of the Rock Creek population achieving at least “maintained” status (moderate risk).

		Risk Rating for Spatial Structure and Diversity			
Risk Rating for Abundance/Productivity		Very Low	Low	Moderate	High
	Very Low (<1%)		***North Fork John Day R.***	***Middle Fork John Day R. South Fork John Day R.***	
	Low (1–5%)				
	Moderate (6–25%)			***John Day R.–Lower Mainstem Tribs. John Day R.-Upper Mainstem***	
	High (>25%)				

Figure 4. John Day River MPG population risk ratings integrated across the four VSP parameters. Viability key: dark green – highly viable; light green – viable; orange – maintained; and red – high risk (does not meet viability criteria) (Ford 2022, Table 27, p. 110).

The John Day River MPG is not viable. The John Day River MPG does not meet the viability criteria of the Lower Mainstem John Day River, North Fork John Day River, and either the Middle Fork John Day River or Upper Mainstem John Day populations achieving viable status (low risk), with one highly viable (very low risk) population since both the John Day Lower Mainstem and the John Day Upper Mainstem populations remain at a “maintained” status (low risk).

		Risk Rating for Spatial Structure and Diversity			
Risk Rating for Abundance/Productivity		Very Low	Low	Moderate	High
	Very Low (<1%)				
	Low (1–5%)			***Satus Cr.***	
	Moderate (6–25%)			***Toppenish Cr. Naches R.***	***Yakima R. Upper Mainstem***
	High (>25%)				

Figure 5. Yakima River MPG population risk ratings integrated across the four VSP parameters. Viability key: dark green – highly viable; light green – viable; orange – maintained; and red – high risk (does not meet viability criteria) (Ford 2022, Table 27, p. 110).

The Yakima River MPG is not viable. The Yakima River MPG does not meet the viability criteria of:

- at least two populations achieving viable status (low risk), including at least one of the two, classified as a large population – the Naches River and the Upper Yakima; and
- the remaining two populations achieving at least "maintained" status (moderate risk).

The Naches River population remains at "maintained" status (moderate risk), and the Yakima River Upper Mainstem population is not viable (high risk).

		Risk Rating for Spatial Structure and Diversity			
Risk Rating for Abundance/Productivity		Very Low	Low	Moderate	High
	Very Low (<1%)				
	Low (1–5%)				
	Moderate (6–25%)			***Umatilla R.*** ***Walla Walla R.***	
	High (>25%)			***Touchet R.***	

Figure 6. Walla Walla and Umatilla Rivers MPG population risk ratings integrated across the four VSP parameters. Viability key: dark green – highly viable; light green – viable; orange – maintained; and red – high risk (does not meet viability criteria) (Ford 2022, Table 27, p. 110).

The Walla Walla and Umatilla Rivers MPG is not viable. The Walla Walla and Umatilla Rivers MPG does not meet the viability criteria of:

- two populations achieving viable status (low risk), with one highly viable (very low risk) population;
- the Umatilla River population as the only large population achieving viable status (low risk); and
- either the Walla Walla River or Touchet population achieving viable status (low risk).

Currently both the Umatilla and Walla Walla populations remain at "maintained" status (moderate risk), and the Touchet population remains not viable (high risk).

2.3.2 ESA Listing Factor Analysis

Section 4(a)(1) of the ESA directs us to determine whether any species is threatened or endangered because of any of the following factors: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or man-made factors affecting its continued existence. Section 4(b)(1)(A) requires us to make listing determinations after conducting a review of the status of the species and taking into account efforts to protect such species. Below we discuss new information relating to each of the five factors as well as efforts being made to protect the species.

2.3.2.1 Listing Factor A: Present or threatened destruction, modification or curtailment of its habitat or range

Significant habitat restoration and protection actions at the Federal, state, and local levels have been implemented to improve degraded habitat conditions and resolve fish passage issues described in the 2009 Middle Columbia River Steelhead Recovery Plan. While these efforts have been substantial and are expected to benefit the survival and productivity of the targeted populations, we do not yet have evidence demonstrating that improvements in habitat conditions have led to improvements in population viability. The effectiveness of habitat restoration actions and progress toward meeting the viability criteria should be monitored and evaluated with the aid of newly implemented monitoring and evaluation programs. Generally, it takes one to five decades to demonstrate such increases in viability.

In the 2020 Columbia River System (CRS) biological opinion (NMFS 2020b), NMFS concluded that while some degraded areas in the Middle Columbia River steelhead DPS are likely improving because of restoration actions and improved land-use practices, in general tributary habitat conditions are still degraded through past and present anthropogenic activities (levees, water withdrawals, roads, dams, etc.). These degraded habitat conditions continue to negatively affect Middle Columbia River steelhead abundance, productivity, spatial structure, and diversity. In addition, ongoing development and land-use activities may also have negative effects into the foreseeable future.

The following section describes the tributary habitat for each MPG within the MCR steelhead DPS. Migration corridor habitat in the Columbia River is vitally important to the MCR steelhead and is addressed under *Listing Factor C (Disease and Predation)* and *Listing Factor D (Inadequacy of Regulatory Mechanisms: Columbia River System).*

Current Status and Trends in Habitat

Below, we summarize information on the current status and trends in tributary habitat conditions by MPG since our last 2016 5-year review. We specifically address:

(1) population-specific key emergent or ongoing habitat concerns (threats or limiting factors) focusing on the top concerns that potentially have the biggest impact on independent population viability;

(2) population-specific geographic areas of habitat concern (e.g., independent population major/minor spawning areas) where key emergent or ongoing concerns about this habitat condition remain;

(3) population-specific key protective measures and major restoration actions taken since the 2016 5-year review toward achieving the recovery plan viability criteria established by the recovery plan (NMFS 2009) as efforts that substantially address a key concern noted in **above #1 and # 2**, or that represent a noteworthy conservation strategy;

(4) key regulatory measures that are either adequate, or, inadequate and contributing substantially to the key tributary habitat concerns summarized above; and

(5) recommended future recovery actions over the next five years toward achieving population viability, including: key near-term restoration actions that would address the key concerns summarized above; projects to address monitoring and research gaps; fixes or initiatives to address inadequate regulatory mechanisms, and addressing priority habitat areas when sequencing priority habitat restoration actions.

The following section describes tributary habitat for each MPG. Migration corridor habitat in the Columbia River is vitally important to this DPS and is addressed under *Listing Factor C: (Disease and Predation), Listing Factor D:* (*Inadequacy of Regulatory Mechanisms: Columbia River System*), and *Listing Factor E:* (*Other Natural or Manmade Factors*).

Cascades Eastern Slope Tributaries MPG

1. Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-Year Review

The Cascades Eastern Slope Tributaries MPG includes the following populations: Klickitat River, Rock Creek, White Salmon River (functionally extirpated), Fifteenmile Creek, Deschutes River Eastside, Deschutes River Westside, and Crooked River (extirpated, but reintroduced as a nonessential experimental population (NEP) under the ESA). Ongoing and emerging habitat concerns for this MPG include:

- Low summer stream-flows, altered hydrographs, and elevated water temperatures continue to limit habitat quantity, quality, and resiliency for the Fifteenmile Creek, Deschutes River Eastside, Deschutes River Westside, and Crooked River populations (NMFS 2009, 2016a; ODFW 2010, 2012, 2019a; DRC and DWA 2013; Faber et al. 2018; Macnab and Springston 2019).
- Fish passage barriers at the Tenold, Underhill, and Lyda Diversion Dams on Fifteenmile Creek, and the Highway 197 culvert on Fivemile Creek (Fifteenmile Creek population) (ODFW 2019a).
- Floodplain disconnection and loss of function due to roads and railroad prisms (Klickitat population) (Yakama Nation Fisheries 2020).
- Lack of habitat quantity and diversity, low summer flows and high water temperatures, lost riparian function, disconnected floodplain, increased fine sediment delivery, an altered food web, and non-native fish effects (Rock Creek population) (Hardiman and Harvey 2019; Yakama Nation Fisheries 2020).

2. Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-Year Review

- Documented increased smallmouth bass use of the lower Deschutes River since 2016 that could potentially displace or compete with juvenile steelhead for space and prey resources (Jason Seals, Fish Biologist, ODFW, personal communication, Feb 2, 2021) (Deschutes River Eastside and Deschutes River Westside populations).
- Coldwater refuges in the Columbia River mainstem and its tributaries for returning adult steelhead exposed to high temperatures in the Columbia River (all populations).

3. Population-Specific Key Protective Measures and Major Restoration Actions Taken Since the 2016 5-Year Review

- Improvement of upstream passage at Opal Springs Dam on the lower Crooked River, a tributary to the upper Deschutes River, through the 2019 completion of a fish ladder at RM 7.0, providing volitional access to 125 miles of spawning and rearing habitat (Adrienne Averett, Eastside Implementation Coordinator, ODFW, personal communication, 6/17/2020).
- Continued implementation of the Fifteenmile Creek Action to Stabilize Temperatures (FAST) program that assists irrigators to mitigate low summer flow effects on stream temperatures during warming events (Adrienne Averett, Eastside Implementation Coordinator, ODFW, personal communication, 3/16/2021).
- The 2018 Deschutes River Conservancy (DRC) lease of 19,986 acre-feet of water from 323 individuals protecting 58.2 cubic feet per second (cfs) instream. Working with voluntary participants and irrigation district partners, the DRC leasing program has averaged 60 cfs annually instream from 1998-2018 (https://www.deschutesriver.org/what-we-are-doing/programs/water-rights-leasing/; accessed 2/10/2021).
- The 2020 Columbia Land Trust and SDS Lumber Company announcement of the conservation of 4,900 acres along the Klickitat River Canyon, completing the nearly 11,000-acre Klickitat Canyon Conservation Area. The total Klickitat Canyon Conservation Area includes 7.8 miles of Klickitat River frontage. (https://www.columbialandtrust.org/klickitat-canyon-conserved-2/; accessed 2/10/2021).

4. Key Regulatory Measures Since the 2016 5-Year Review

The NMFS 2009 Middle Columbia River Steelhead Recovery Plan and the previous 5-year review identified inadequate regulatory mechanisms as a priority issue affecting the Cascades East Slopes Tributaries MPG. Various Federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement whereas others have made it more challenging to protect and recover MCR species. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for additional details.

5. Recommended Future Recovery Actions Over the Next Five Years Toward Achieving Population Viability

- Protect the highest quality habitats and apply best management practices to conserve ecological processes that support population viability and primary life history strategies (all populations).
- Implement recovery actions to measurably increase summer streamflow, decrease summer water temperatures, and increase spatiotemporal habitat connectivity and resiliency (Crooked River, Deschutes River Eastside, Deschutes River Westside, Fifteenmile Creek, and Rock Creek populations). Potential actions include: riparian buffer protection, riparian vegetation planting, water conservation actions and agreements, beaver habitat protection and restoration, floodplain-channel reconnection through process-based methods (NMFS 2009; ODFW 2010, 2012, 2019b; Macnab and Springston. 2019; Nelson 2019; EPA 2021).
- Provide upstream passage at the Tenold, Underhill, and Lyda Diversion Dams on Fifteenmile Creek, and at the Highway 197 culvert on Fivemile Creek (ODFW 2019a) (Fifteenmile Creek population).
- Continue to support and implement the Fifteenmile Action Plan for Stream Temperature (FAST) to improve streamflows and water temperatures (Fifteenmile Creek population).
- Protect and enhance identified primary coldwater refuge areas between Bonneville and McNary dams in the Columbia River (EPA 2021).

Key 5-Year MPG Research and Monitoring Recommendations:

- Develop population-specific life cycle models (LCM) to evaluate summer steelhead viability performance under various threat and limiting factor reduction scenarios (McHugh et al. 2017) and contribute to an integrated, Middle Columbia DPS-wide LCM network.
- Maintain data collection in the Klickitat River and Rock Creek watersheds and implement a monitoring plan for the White Salmon River to develop long–term abundance and productivity numbers (Yakama Nation Fisheries 2020).
- Evaluate the population-specific incidence, causal mechanisms, and viability effects of Fifteenmile Creek and Deschutes River wild, pre-spawn adult steelhead mortality between Bonneville Dam and The Dalles Dam (Pierson et al. 2017; ODFW 2019b; DART 2020a).
- Evaluate the population-specific incidence, causal mechanisms, and viability effects of tributary overshoot on the Fifteenmile Creek population.

John Day River MPG

1. Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-Year Review

The John Day River MPG includes the John Day River Lower Mainstem Tributaries, North Fork John Day River, Middle Fork John Day River, John Day River Upper Mainstem, and South Fork John Day River populations. Ongoing and emerging habitat concerns for this MPG include:

- High stream temperatures and low summer baseflow conditions in tributaries (Bare et al. 2017, 2019; McHugh et al. 2017; Middle Fork Intensively Monitored Watershed Working Group 2017; ODFW 2019b) (all populations). Irrigation withdrawal is one example of the factors contributing to these conditions.
- Degraded floodplain connectivity and function, channel structure and complexity, and riparian communities and large wood recruitment (all populations).
- Insufficient fish passage and irrigation diversion screening in the Lower Mainstem and Upper Mainstem John Day River population areas.
- John Day River wild, pre-spawn adult steelhead mortality in the Bonneville Dam to the Dalles Dam reach averaged 16 percent during 2013-2019 (DART 2020b). Maintaining perpetual surface-water migration routes, providing sufficient flows and low water temperatures may reduce tributary overshoot pre-spawn mortality.
- Tributary overshoot - Approximately 53 percent of wild John Day adult steelhead overshoot their natal tributaries and migrate above McNary Dam. An imprecisely quantified percentage successfully return to the John Day River to spawn (Carmichael et al. 2012; Ruzycki and Tattam 2014; Ruzycki et al. 2015; Bare et al. 2017; ODFW 2017; Richins 2017; ODFW 2019b). This is a habitat concern because downstream dam passage can be hazardous for large adult fish and can contribute to migration delays. (All populations).

2. Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-Year Review

- Coldwater refuges in the Columbia River mainstem and its tributaries needed for returning adult steelhead exposed to high temperatures in the mainstem (all populations) as identified in EPA's Columbia River Cold Water Refuges Plan (EPA 2021).

3. Population-Specific Key Protective Measures and Major Restoration Actions Taken Since the 2016 5-Year Review

- The Confederated Tribes of Warm Springs (CTWS) fenced 169 acres of riparian area and planted 235 acres of riparian, for a total of 4.3 riparian miles treated; they placed 1,292 large wood structures, constructed 0.57 miles of channel, restored 15.83 miles of channel, completed 3,374 feet of off-channel work to improve degraded channel structure and complexity and degraded floodplain function and connectivity and improve low stream flow and elevated water temperatures. Restoration actions also addressed 40 passage barriers to improve fish passage (Amy Charette, Watershed Restoration Coordinator, Confederated Tribes of Warm Springs, personal communication, March 16, 2021) (Lower John Day, Middle Fork, North Fork, and Upper John Day populations).

- The Malheur National Forest completed 13.7 miles of riparian fencing, 5.8 miles of riparian planting, and 25 large wood projects from 2016-2020, addressing water temperature and stream function (unpublished data provided by Erika Porter, Fisheries Technician Stream Survey Data Manager, USFS, March 10, 2021) (Middle Fork John Day, North Fork John Day, and Upper John Day populations).
- The Freshwater Trust worked with landowners to protect about 18,000 gallons per minute from 2016-2019 (all populations). Agreements included shorter irrigation seasons, water withdrawals only when certain minimum flows are met, and voluntary leases of water rights (https://www.thefreshwatertrust.org/case-study/the-john-day/; accessed March 25, 2021).
- Grant Soil and Water Conservation District fenced 2.1 stream miles to protect from cattle grazing (North Fork John Day population). The project will stabilize streambanks, reduce sedimentation to improve degraded channel structure, stream complexity, and improve sediment routing. These projects should also improve streambank native riparian vegetation will lead to increase stream shade and improve water temperatures. (https://www.johndaybasinpartnership.org/Project/Index; accessed March 25, 2021).
- The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) installed 11 beaver dam analogs and 187 large wood structures, and planted riparian areas. These projects enhanced 0.8 miles of stream and created 0.6 miles of side channel habitat (North Fork John Day population). Collaborators included the Umatilla National Forest and private landowners (https://www.johndaybasinpartnership.org/Project/Index; accessed March 25, 2021).
- The John Day Basin Partnership adopted the BPA's Atlas tool to prioritize the most cost-effective projects that address high stream temperatures and low instream flows (all populations) (John Day Partnership 2018).

4. Key Regulatory Measures Since the 2016 5-Year Review

The NMFS 2009 Middle Columbia River Steelhead Recovery Plan and the previous 5-year review identified inadequate regulatory mechanisms as a priority issue affecting the John Day River MPG. Various Federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement whereas others have made it more challenging to protect and recover MCR steelhead. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

5. Recommended Future Actions Over the Next Five Years Toward Achieving Population Viability

- Decrease summer stream temperatures and increase summer baseflow connectivity and complexity in the John Day River watershed (all populations). Achieve these through a combination of riparian protection (e.g., fencing to manage grazing and browsing impacts), process-based restoration of floodplain-riparian habitats, and, where practical, water leasing or purchase agreements (McHugh et al. 2017; Middle Fork Intensively Monitored Watershed Working Group 2017; Weber et al. 2017; Macfarlane et al. 2018, 2019; Wathen et al. 2018; ODFW 2019b citing MacFarlane et al. 2017; Silverman et al. 2019; EPA 2021).
- Further reduce the effects of grazing in the Middle Fork John Day, roads, and water withdrawal for irrigation (including the removal of legacy structures in the floodplain) on Federal lands, to improve floodplain and riparian function, and channel structure.
- Improve fish passage and irrigation screening in areas affecting the Lower Mainstem and Upper Mainstem John Day River populations (ODFW 2019b).
- Protect and enhance Columbia River habitat in identified coldwater refuge areas between Bonneville and McNary Dams (WDFW 2019; ODFW 2020; EPA 2021).

Key 5-Year MPG Research and Monitoring Recommendations:

- Expand the Middle Fork John Day summer steelhead life cycle model (LCM) to all John Day River MPG populations to evaluate summer steelhead viability performance under various threat and limiting factor scenarios (McHugh et al. 2017) and contribute to an integrated, Middle Columbia DPS-wide LCM network for testing/applying lessons learned and recommendations from Pess and Jordan (2019).
- Continue implementation of the John Day Basin Partnership's integrated habitat restoration-effectiveness monitoring framework (OWEB Focused Investment Partnership).
- Evaluate the population-specific incidence and causal mechanisms for John Day River wild, pre-spawn adult steelhead mortality (the only wholly wild MPG in the MCR steelhead DPS) between Bonneville Dam and The Dalles and John Day Dams (DART 2020b).
- Continue tagging John Day origin adult steelhead in the Columbia River to evaluate the mechanisms driving overshoot to better quantify the probability of successful return for overshoots from the John Day River MPG (all populations).

Yakima River MPG

1. Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-Year Review

The Yakima River MPG includes the Satus, Toppenish, Naches, and Upper Yakima River populations. Ongoing habitat concerns for this MPG include:

- Altered mainstem flow regimes, physical impacts of diversions on juveniles and smolts, and changes in predation rates resulting from in the Bureau of Reclamation's Yakima Project infrastructure and operations (all populations) (YBFWRB 2015).
- Altered stream hydrology and channels from land management and levees resulting in loss/reduced floodplain connectivity and riparian habitat (all populations).
- Fish passage barriers (Upper Yakima River population) (YBFWRB 2015) that limit spatial diversity and productivity.
- Smolt entrainment through water diversion structures for irrigation and wetland management (Toppenish Creek population).
- Migratory corridor habitat conditions from Bonneville Dam to Prosser Dam that result in about 40 percent of adults lost prior to reaching Prosser (all populations) (Conley 2020).
- Reduced stream flows (all populations) (YBFWRB 2015). Generally, reduced flows most severely impact juvenile rearing and smolt outmigration.
- Degraded habitat conditions from grazing (all populations). Example streams include Cowiche, Ahtanum, and Swauk Creeks, and Teanaway Basin streams (YBFWRB 2015).
- Severely compromised habitat in both the Tieton River (Naches population) and Wenas Creek (Upper Yakima population) by a combination of altered instream flows, entrainment at diversion facilities, and major passage barriers (YBFWRB 2009) (Tieton Dam and Wenas Dam).

2. Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-Year Review

- Lack of habitat development because of regulated spring flows in the Upper Yakima and Yakima River (all populations).
- Habitat causes of smolt mortality at the Bureau of Reclamation's Roza, Sunnyside, and Prosser dams, as well as the Bureau of Indian Affairs' Wapato Dam (all populations).
- Fish passage barriers at Cle Elum, Keechelus, and Kachess Dams and barriers in the Wilson-Naneum, Caribou, and Wenas watersheds (Upper Yakima River population). Fish passage barriers at Tieton and Bumping Dams (Naches population).
- Entrainment through water diversion structures for irrigation and wetland management at Toppenish Creek (Toppenish Creek population).

3. Population-Specific Key Protective Measures and Major Restoration Actions Taken Since the 2016 Review

- Removal of the last fish passage barrier (the old Reed diversion dam) on Manastash Creek, providing access to more than 20 miles of habitat (Upper Yakima River population).
- Start of construction of fish passage facilities at Cle Elum Dam (Upper Yakima River population).
- On-going floodplain habitat improvements in the lower Naches River and the "Gap to Gap" reach of the Yakima mainstem by Yakima County, and the purchase of important floodplain habitat along the Yakima River near Ellensburg by Kittitas County (Naches and Upper Yakima River populations).
- Interim modifications to Sunnyside Diversion Dam to reduce smolt entrainment and mortality (Naches and Upper Yakima River populations).

4. Key Regulatory Mechanisms Since the 2016 5-Year Review

The NMFS 2009 Middle Columbia River Steelhead Recovery Plan and the previous 5-year review identified inadequate regulatory mechanisms as a priority issue affecting the Yakima River MPG. Various Federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has stayed about the same, with some mechanisms showing the potential for some improvement whereas others have made it more challenging to protect and recover MCR steelhead. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

5. Recommended Future Actions Over the Next Five Years Toward Achieving Population Viability

- Increase April and May river flows from Roza Dam to the mouth of the Yakima River (all populations).
- Modify Prosser Dam to prevent steelhead entrainment into the Prosser Canal (all populations).
- Modify Roza Dam to ensure that all steelhead smolts are passed through surface spill (Upper Yakima population).
- Monitor effectiveness of the interim smolt passage project at Sunnyside Dam and determine how to proceed with a permanent modification (Upper Yakima and Naches populations).
- Complete the Cle Elum Dam fish passage project and establish steelhead spawning above Cle Elum Reservoir (Upper Yakima population).
- Remove all or part of the Bateman Island causeway to allow improved steelhead passage (all populations).

- Develop a strategic plan and prioritization of levee setback projects along the Yakima River to improve floodplain function (all populations).
- Protect riparian areas from grazing and improve instream flows through water conservation projects and water acquisition in Cowiche, Ahtanum, and Swauk Creeks, and Teanaway Basin streams (Upper Yakima and Naches populations).

Key 5-Year MPG Research and Monitoring Recommendations:

- Identify the sources of smolt mortality in Toppenish Creek related to habitat issues, including water diversion structures.
- Improve monitoring of the Satus Creek population (i.e., smolt estimates and PIT-tagging for outmigration survival and Smolt-to-adult return analyses).
- Monitor effectiveness of modifications or operational changes at major water diversion dams intended to improve smolt survival.

Walla Walla and Umatilla Rivers MPG

1. Population-Specific Key Emergent or Ongoing Habitat Concerns Since the 2016 5-Year Review

The Walla Walla and Umatilla Rivers MPG includes the Walla Walla, Umatilla, and Touchet Rivers populations. A fourth population, Willow Creek, is considered functionally extirpated.

- Low streamflows, high water temperatures, degraded habitat quantity and quality (instream, riparian, excess sediment), a lack of floodplain function, and impaired access to historic habitat areas (Hanson et al. 2017, 2020; ODFW 2019b) (Umatilla, Walla Walla, and Touchet populations).
- Limited floodplain and riparian habitat function due to the Milton-Freewater levee system and its maintenance under the Corps' PL 84-99 program on the Walla Walla River (Walla Walla population).
- Impaired fish passage to upstream habitat at Bennington Dam, Nursery Bridge Dam (Walla Walla population), and McKay Dam (Umatilla population).
- Fish passage - Columbia River mainstem migratory corridor between Bonneville Dam and the Dalles Dam resulting in an average of 13 percent wild, pre-spawn adult Umatilla River and Walla Walla steelhead mortality from 2013-2019 (DART 2020b), and an estimated annual wild adult steelhead pre-spawn mortality between Bonneville Dam and John Day Dam is approximately 26 percent (Hanson 2018).
- Habitat concerns resulting in tributary overshoot – approximately 44 percent of wild Umatilla River steelhead and 37 percent of Walla Walla River wild steelhead overshoot above McNary and Snake River Dams (Richins 2017; Hanson 2018).

2. Population-Specific Geographic Areas of Habitat Concern Since the 2016 5-Year Review

- The BLM managed access route that provides access to inholdings in the **South Fork Walla Walla River** is a concern due to numerous fords and recent road reconstruction to maintain access.

3. Population-Specific Key Protective Measures and Major Restoration Actions Taken Since the 2016 5-Year Review

The following information was provided by John Foltz (Executive Director, Snake River Salmon Recovery Board) via personal communication in March 2020 and August 2021.

- Approximately 2,500 feet of the 10,000-foot concrete channel section of the Mill Creek Flood Control Project was modified to provide fish passage (Walla Walla population).
- The Corps upgraded the Division Works fish ladder on Mill Creek in 2020, providing volitional passage to both adults and juveniles. The new design will work in a wider range of flows making it easier for adult steelhead to pass upstream (Walla Walla population).
- The Corps upgraded the Yellowhawk diversion works fish ladder, improving passage for adult and juvenile steelhead (Walla Walla population).
- Three fish passage barriers were fixed allowing access to 10.2 miles of Dry Creek, and 2 miles of Titus Creek (Walla Walla population).
- A levee setback and large wood additions increased habitat complexity in 0.63 miles of the N. Touchet River (Touchet River population).
- A water lease with Gardena Farms conserved 14 cfs of water (Walla Walla River population).
- The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) worked with the City of Walla Walla to provide up to 6 cfs of base flow in Mill Creek through water infrastructure upgrades (Walla Walla population).
- The CTUIR and the Mill Creek Working Group completed the Lower Mill Creek Habitat Assessment and Strategic Action Plan in 2018, and the CTUIR completed the Lower Walla Walla Habitat Assessment and Strategic Action Plan (Walla Walla population).

4. Key Regulatory Measures Since the 2016 5-Year Review

The NMFS 2009 Middle Columbia River Steelhead Recovery Plan and the previous 5-year review identified inadequate regulatory mechanisms as a priority issue affecting the Walla Walla MPG. Various Federal, state, and county regulatory mechanisms are in place to minimize or avoid habitat degradation caused by human use and development. New information available since the last 5-year review indicates that the adequacy of a number of regulatory mechanisms has stayed the same on average, with some mechanisms showing the potential for some improvement whereas others have made it more challenging to protect and recover MCR steelhead. See *Listing Factor D: Inadequacy of Regulatory Mechanisms* in this document for details.

5. Recommended Future Actions Over the Next Five Years Toward Achieving Population Viability

- Continue flow and passage improvements in the Umatilla (Bureau of Reclamation), Walla Walla and Touchet Rivers, especially at Bennington Dam, the Mill Creek channel, and at Nursery Bridge.
- Construct a new Bennington Dam fish ladder.
- Complete the Walla Walla Integrated Flow Enhancement Study, which should include selecting an alternative and implementation.
- Provide passage: (1) and evaluate reintroduction feasibility over McKay Dam, a high priority passage action identified by the State of Oregon (Umatilla population); and (2) up Mill Creek, a tributary to the Walla Walla River to achieve abundance, productivity, and spatial structure goals for summer-run steelhead (Walla Walla population).
- Implement the Walla Walla Water 2050 Strategic Plan, including implementing levee setback projects up- and downstream of Milton Freewater (Walla Walla population).
- Work with Federal land managers and stakeholders to develop alternative routes to access private land on the South Fork Walla Walla River to ensure functional stream and riparian habitat for the Walla Walla population.
- Protect and enhance Columbia River coldwater refuge areas between Bonneville and McNary Dams (EPA 2021).

Key 5-Year MPG Research and Monitoring Recommendations:

- Develop population-specific life cycle models (LCM) to evaluate various threat and limiting factor reduction scenarios (McHugh et al. 2017).
- Evaluate the population-specific incidence and causal mechanisms for Umatilla River and Walla Walla River wild, pre-spawn adult steelhead mortality between Bonneville Dam and The Dalles and John Day Dams (Hanson 2018; DART 2020c, 2020d).
- Evaluate the population-specific incidence and viability effects of tributary overshoot on the Walla Walla and Umatilla Rivers MPG (Carmichael et al. 2012; Murdoch et al. 2012; Ruzycki and Hanson 2014; Ruzycki et al. 2015; Keefer et al. 2016; Richins and Skalski 2018; ODFW 2019b).

Listing Factor A Conclusion

New information since the last 5-year review indicates there is improvement in freshwater and estuary habitat conditions for MCR steelhead spawning, rearing, and migration in some locations. In particular, the construction of a fish ladder at Opal Springs Dam gave steelhead access to 125 miles of habitat in the Crooked River drainage (Cascades Eastern Slope Tributaries MPG), and removal of the final barrier on Manastash Creek (Yakima River MPG), opened access to more than 20 miles of new tributary habitat. Improvements to fish passage and numerous tributary habitat restoration and enhancement projects involving large wood supplementation, floodplain reconnection, riparian fencing and replanting, and work with property owners to increase water conservation and summer flows should result in improved survival for this DPS.

However, widespread areas of degraded or inaccessible habitat continue to persist for all four MPG's due to: (1) dams and irrigation infrastructure; (2) low summer flows and high summer water temperatures; (3) disconnected floodplains; and (4) loss of riparian function. Other factors pertain to some MPG's more than others, such as grazing effects in the John Day River MPG, and levees in the Walla Walla and Umatilla Rivers and in the Yakima River MPG's. Finally, the effects of increasing floodplain development and other anthropogenic factors likely offset at least some restoration benefits, but are not well documented or quantified. There remain numerous opportunities for habitat restoration or protection throughout the range of this DPS. Additional priority recovery actions and best management practices that apply to all populations and protect the highest quality habitats and conserve ecological processes that support population viability are necessary to bring this DPS to viable status. Future 5-year assessments would benefit from a systematic review and quantitative analysis of the amount of habitat addressed versus the priority watershed reaches targeted for protection and restoration activities in the 2009 recovery plan in order to track progress against plan objectives.

We therefore conclude that there is a moderate to high risk to the MCR steelhead DPS persistence because of habitat destruction or modification. Our conclusion is based on the fact that extensive miles of stream remain inaccessible or unsuitable for steelhead, many legacy habitat threats continue, and threats from on-going development remain.

2.3.2.2 Listing Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

Harvest

Encounters of steelhead in the ocean fisheries are rare and incidental impacts to steelhead in ocean fisheries targeting other species are inconsequential to very rare (PFMC 2020). The majority of harvest related impacts on MCR steelhead occurs in the mainstem Columbia River. Fisheries that impact MCR steelhead are subject to fisheries management provisions of the *U.S. v. Oregon* Management Agreement. A new 10-year agreement (2018-2027) was adopted since the last 5-year review and limits on incidental harvest rates for MCR steelhead have remained the same (NMFS 2018). Pursuant to the Agreement, non-treaty fisheries are managed subject to limits on the winter and summer components of the MCR steelhead DPS of 2 percent and 4 percent, respectively (NMFS 2018). Over the past six years (run year 2014 through 2019), harvest rates of MCR steelhead have remained relatively constant. In non-treaty fisheries, harvest rates on the winter and summer components of the DPS have averaged 0.4 percent and 1.8

percent, respectively (TAC 2015, 2016, 2017, 2018, 2019, 2020). There are no specific limits for impacts in treaty fisheries for MCR steelhead but harvest rates have remained the same since the last 5-year review and are not expected to change under the 2018 Management Agreement (NMFS 2018).

Research and Monitoring

The quantity of MCR steelhead take authorized under ESA sections 10(a)(1)(A) and 4(d) for scientific research and monitoring remains low, and much of the work being conducted is done for the purpose of fulfilling state and Federal agency obligations under the ESA to ascertain the species' status. Authorized mortality rates associated with scientific research and monitoring are generally capped at 0.5 percent across the West Coast Region for all listed salmonid ESUs and DPSs. As a result, the mortality levels that research causes are very low throughout the region. In addition, and as with all other listed salmonids, the effects research has on MCR steelhead are spread out over various reaches, tributaries, and areas across the range of this DPS, and thus no area or population is likely to experience a disproportionate amount of loss. Therefore, the research program, as a whole, has only a very small impact on overall population abundance, a similarly small impact on productivity, and no measurable effect on spatial structure or diversity for MCR steelhead.

Any time we seek to issue a permit for scientific research, we consult on the effects that the proposed work would have on each listed species' natural- and hatchery-origin components. However, because research has never been identified as a threat or a limiting factor for any listed species, and because most hatchery fish are considered excess to their species' recovery needs, examining the quantity of hatchery fish taken for scientific research would not inform our analysis of the threats to a species' recovery. Therefore, we only discuss the research-associated take of naturally-produced fish in these sections. From 2015 through 2019, researchers were approved to take an average of fewer than 3,000 adult (<40 lethally) and fewer than 139,000 juvenile (<2,700 lethally) MCR steelhead per year (NMFS APPS database; https://apps.nmfs.noaa.gov/). For the vast majority of scientific research permits, history has shown that researchers generally take far fewer salmonids than the number authorized every year. Over the same five-year period, the actual average reported total take was fewer than 500 adults (<3 lethally) and fewer than 34,000 juveniles (<320 lethally) per year.

The majority of the requested research take for MCR steelhead juveniles has been (and is expected to continue to be) capture via screw traps, electrofishing units, beach seines, and hook and line angling, with smaller numbers being captured in fyke nets, minnow traps, and other seines and nets. Adult MCR steelhead take has been and is expected to continue to be requested primarily as capture via weirs, fish ladders, and hook and line sampling angling, with smaller numbers that may be unintentionally captured by screw traps, seining, and other methods targeting juveniles (NMFS APPS database; https://apps.nmfs.noaa.gov/). Our records indicate that mortality rates for screw traps are typically less than one percent and backpack electrofishing are typically less than three percent. Unintentional mortality rates from seining, dip netting, minnow traps, weirs, and hook and line methods are also limited to no more than three percent. Also, a small number of adult fish may die as an unintended result of research because of interactions with trawl sampling equipment.

The quantity of take of naturally produced fish authorized over the past five years has decreased compared to the prior five years: the total take authorized from 2015 through 2019 was 13 percent lower than the total take authorized from 2010 to 2014, and lethal take authorized from 2015 through 2019 was 23 percent lower than what had been authorized from 2010 to 2014. Actual numbers of take reported from 2015 through 2019 also decreased, with total take decreasing almost 29 percent and lethal take decreasing almost 55 percent compared to the prior five years.

Overall, research impacts on MCR steelhead remain minimal due to the low mortality rates authorized under research permits and the fact that the research is spread out across the species' range. In addition, because the amount of take and number of mortalities have been decreasing over the last five years, the overall effect of research on listed populations is actually less than it was at the time of the last 5-year review (NMFS 2016a). We therefore conclude that the risk to the species' persistence because of utilization related to scientific studies remains low.

Listing Factor B Conclusion

New information available since the last 5-year review indicates that the 2018-2027 *U.S. v. Oregon* Management Agreement has, on average, maintained reduced harvest impacts on MCR steelhead (TAC 2015, 2016, 2017, 2018, 2019, 2020). Scientific research impacts authorized through the West Coast Region have decreased compared to the prior five years (NMFS APPS database; https://apps.nmfs.noaa.gov/). Impacts from these sources of mortality are not considered to be major limiting factors for this DPS. Therefore, we conclude that the risk to the species' persistence because of overutilization remains essentially unchanged since the 2016 5-year review with harvest and research/monitoring sources of mortality continuing to have little to no impact on the recovery of the MCR steelhead DPS.

2.3.2.3 Listing Factor C: Disease and Predation

Disease

There is no information indicating that disease rates have changed over the past five years, leading us to conclude that rates are consistent with the previous review period. Climate change impacts such as increasing temperature likely increase susceptibility to diseases.

Avian Predation

Avian predation in the lower Columbia River estuary

Piscivorous colonial waterbirds, especially terns, cormorants, and gulls, have had a significant impact on the survival of juvenile salmonids in the Columbia River. Caspian terns on Rice

Island, an artificial dredged-material disposal island in the estuary, consumed about 5.4 to 14.2 million juveniles per year in 1997 and 1998 (up to 15 percent of all the smolts reaching the estuary (Roby et al. 2017). Efforts to move the tern colony closer to the ocean at East Sand Island, where they would diversify their diet to include marine forage fish, began in 1999. During the next 15 years, smolt consumption was about 59 percent less than when the colony was on Rice Island. The Corps has further reduced smolt consumption by reducing the amount of bare sand available on East Sand Island for nesting from 6 acres to 1 acre. Combined with harassment (kleptoparasitism) by bald eagles, and egg and chick predation by gulls, the number of nesting pairs has dropped from more than 10,000 in 2008 to fewer than 5,000 in 2018 and 2019 (Roby et al. 2021).

Based on PIT-tag recoveries at East Sand Island, the average annual tern predation rate for this DPS was about 17.1 percent, before efforts to manage the size of this colony (Roby et al. 2021). Tern predation rates have decreased to 10.1 percent since 2007. This improvement was offset to an unknown degree by about 1,000 terns trying to nest on Rice Island (Evans et al. 2018) and smaller numbers roosting or trying to nest on Rice, Miller and Pillar Islands in 2018 and 2019 (Harper and Collis 2018).

The average annual cormorant predation rate for this DPS was about 7.5 percent before the management plan for double-crested cormorants was implemented, and the vast majority of those in the Columbia River estuary nested on East Sand Island. Starting in 2016, however, cormorants did not establish a nesting colony throughout the entire peak of the smolt outmigration period (April to June). Instead, large numbers of birds dispersed to other locations, especially the Astoria-Megler Bridge where smolts are likely to constitute a larger proportion of the diet. The average annual predation rates on MCR steelhead reported by Lawes et al. (2021) for the East Sand Island cormorant colony during the two post-management periods (5.4 percent during 2015 to 2017 and 0.4 percent in 2018) therefore cannot be directly compared to those before management began, and are likely to underestimate predation rates in the estuary.

Overall, avian predation on MCR steelhead may have decreased slightly since the 2016 5-year review, although those decreases may be offset by the movement of cormorants from East Sand Island to the Astoria-Megler Bridge. Avian predation impacts to MCR steelhead remain relatively high in the Columbia River estuary.

Avian predation in the mainstem Columbia

MCR steelhead survival is affected in the mainstem by avian predators that forage at the mainstem dams and in the reservoirs. The Federal action agencies for the Columbia River System biological opinion are required to implement avian predation measures to increase the survival of juvenile salmonids in the Columbia River through effective monitoring, hazing and deterrents.

Juvenile MCR steelhead are vulnerable to predation by terns nesting in the interior Columbia plateau, including colonies on islands in McNary Reservoir, in the Hanford Reach, and in

Potholes Reservoir. Current management strives to keep predation rates to less than 2 percent for the DPS per tern colony per year with no more than 200 pairs at sites across the interior plateau. The primary management activities have been focused on keeping terns from nesting on Goose Island in Potholes Reservoir and on Crescent Island in McNary Reservoir using passive dissuasion, hazing and revegetation. The Corps has been successful at preventing terns from nesting on Crescent Island since 2015, and similar efforts are in progress at Goose Island. Although Roby et al. (2021) do not report predation rates on MCR steelhead at the Blalock Islands, it is likely that they have been high since management activities began at Crescent and Goose Islands, similar to other species.

There are no regional plans to manage predation by gulls. PIT-tag recoveries indicate that predation rates on juvenile Snake River Basin steelhead by gulls on Miller Rocks averaged 7.2 percent during 2007 to 2019 (Cramer et al. 2021). If predation rates on MCR steelhead are similar, they may have averaged more than 2 percent per colony for gulls nesting on Badger Island, Crescent Island, and the Blalock Islands in recent years (Cramer et al. 2021).

Cumulative predation rates across tern and gull colonies could be high, but estimation is complicated by the distribution of MCR steelhead spawning areas in the middle Columbia River. The Walla Walla population is vulnerable to predation by more colonies than is the Deschutes population, for example. Evans et al. (2021) were able to estimate cumulative predation rates for other interior DPSs that spawn upstream of all these colonies; these have ranged from 31 to 53 percent for UCR steelhead and 18 to 46 percent for SRB steelhead per year.

In summary, information above indicates that predation rates could be around 10.1 percent and 5.4 percent for terns and cormorants, respectively in the estuary (a total of 15.5 percent). In the mainstem Columbia River, cumulative predation rate estimation from tern and gull colonies has ranged from 18 to 53 percent for other steelhead DPSs originating upstream of those colonies. Even if mainstem predation rates on MCR steelhead are at the low end of this range (i.e., 18 percent), total avian predation in the Columbia River estuary and mainstem combined appears to be a significant factor limiting juvenile MCR steelhead survival.

Pinniped Predation

Numbers of pinnipeds that are predators of adult salmonids have increased considerably in the Pacific Northwest since the Marine Mammal Protection Act (MMPA) was enacted in 1972 (Carretta et al. 2013). California sea lions *(Zalophus californianus)*, Steller sea lions *(Eumetopias jubatus)*, and harbor seals *(Phoca vitulina)* all consume salmonids from the mouth of the Columbia River and its tributaries up to the tailrace of Bonneville Dam. The ODFW counted the number of individual California sea lions hauling out in the Columbia River mouth at the East Mooring Basin in Astoria, Oregon, from 1997 through 2017.

Pinniped counts at the East Mooring Basin during July and August, when MCR steelhead are migrating, remained stable during 2008 to 2016, with a maximum count of 423 California sea lions in August 2014 (Wright 2018). There tends to be relatively few sea lions at the mooring basin in July (range of 3 in 2016 to 38 in 2009).

Estimates of steelhead predation by pinnipeds in the lower Columbia River estuary (i.e., downstream of the Bonneville tailrace) are not available for the late summer time period when MCR steelhead adults are migrating. Instead, monitoring efforts have focused on California sea lion predation on Snake River spring/summer Chinook salmon during January to May (e.g., Rub et al. 2019). Pinniped presence in the Bonneville tailrace during the MCR steelhead adult migration in the summer and fall, has increased in the last 6 years (Tidwell et al. 2020). Steller sea lions in particular aggregate at the base of the dam in the late summer when MCR steelhead are present. Between July 21 and December 31, 2018, Tidwell et al. (2018) documented an average of 14.5 Steller sea lions at Bonneville Dam and, during many occasions, counted more than 20 individuals. A small number of California sea lions have also been observed in Bonneville Reservoir but have since been removed. The percentage of steelhead estimated to be consumed by pinnipeds in 2018 was 1.6 percent (Tidwell et al. 2020), and we assume that the percentage of MCR steelhead consumed was similar. Excluding the known impact in the Bonneville Dam tailrace, average pinniped impacts to summer migrating adult MCR steelhead through the lower Columbia River are likely relatively minor because of low pinniped counts at that time, and they are mixed with relatively abundant fall Chinook salmon migrating in September and October.

The United States Congress (Congress) amended the MMPA in 1994 to include a new section, section 120 – Pinniped Removal Authority. This section provides an exception to the MMPA "take" moratorium and authorizes the Secretary of Commerce to authorize the intentional lethal taking of individually identifiable pinnipeds that are having a significant negative impact on the decline or recovery of salmonid fishery stocks. In 2018, Congress amended section 120(f) of the MMPA, which expanded the removal authority for removing predatory sea lions in the Columbia River and tributaries.

To address the severity of pinniped predation in the Columbia River Basin, NMFS has issued six MMPA section 120 authorizations (2008, 2011, 2012, 2016, 2018, and 2019) and one section 120(f) permit (2020). Under these authorizations, as of May 13, 2022, the states have removed (transferred and killed) 278 California sea lions and 52 Steller sea lions. Removal of sea lions in the Columbia River has protected (fish escaping sea lion predation) an estimated 62,284 to 83,414 adult salmon and steelhead in the Columbia River Basin.

Continued management action under the MMPA is expected to reduce sea lion predation on adult salmon and steelhead in the Columbia River. Given the logistical challenges of removing sea lions and other uncertainties, the magnitude of this expected reduction in sea lion predation is uncertain.

Fish Predation

Northern Pikeminnow

The native northern pikeminnow is a significant predator of juvenile salmonids in the Columbia and Snake Rivers followed by non-native smallmouth bass and walleye (reviewed in Friesen and Ward 1999; ISAB 2011, 2015). Before the start of the Northern Pikeminnow Management Plan (NPMP), this species was estimated to eat about 8 percent of the 200 million juvenile salmonids that migrated downstream in the Columbia River each year. Williams et al. (2017) compared current estimates of northern pikeminnow predation rates on juvenile salmonids to before the start of the program and estimated a median reduction of 30 percent (i.e., down to about 6 percent of juvenile salmonid migrants). Based on this, we assume that about 6 percent of MCR steelhead juvenile migrants are preyed upon by northern pikeminnow.

The NPMP's Sport Reward Fishery removed an average of 188,798 piscivorous pikeminnow per year during 2015 to 2019 in the Columbia and Snake Rivers (Williams et al. 2015, 2016, 2017, 2018; Winther et al. 2019). Sport Reward Fishery harvest from the area below Bonneville Dam accounted for 62 percent of total fishery removals in 2019, and 54 percent in 2018, and has been the highest-producing zone for all but one season since system-wide implementation began in 1991 (Williams et al. 2018; Winther et al. 2019). In the 2018 and 2019 Sport Reward Fishery, the second highest pikeminnow catch (removal) location was Bonneville Reservoir. From 2015 to 2019, an annual average of 42 adult and 198 juvenile steelhead per year were incidentally caught in the Sport Reward Fishery; although it was not practical for the field crews to identify these fish to DPS, we assume that some were MCR steelhead.

In addition to the Sport Reward Fishery, the Federal action agencies conduct a Dam Angling Program to remove large pikeminnow from the tailraces of The Dalles and John Day Dams. Angling crews removed an average of 5,728 northern pikeminnow per year from these projects during 2015 to 2019 (Williams et al. 2015, 2016, 2017, 2018; Winther et al. 2019).

Although northern pikeminnow removal programs may have led to a decreased predation rate on MCR steelhead juveniles (i.e., from 8 percent to 6 percent), this decrease only improves juvenile survival through the migration corridor if it is not offset by a compensatory response from other predators, including other piscivorous fishes (e.g., walleye, smallmouth bass). We discuss these fish below.

Aquatic Invasive Species

Non-indigenous fishes pose a threat to the recovery of MCR steelhead. Threats are not restricted to direct predation; non-indigenous species compete directly and indirectly for resources, significantly changing food webs and trophic structure, and potentially altering evolutionary trajectories. Smallmouth bass, channel catfish, and walleye are documented predators, brook trout are known competitors and American shad may have food web impacts (Sanderson et al. 2009; NMFS 2010; Naiman et al. 2012). In 2016, WDFW and ODFW lifted limits on smallmouth bass, channel catfish, and walleye in the Columbia River in an effort to reduce predator populations.

Smallmouth bass are well established throughout the Columbia River basin and are known to interact with salmonids. Several studies estimated local predatory impacts of bass on salmonids and suggest a range of potential consumption rates of salmonids by bass (Erhardt and Tiffan 2018; Erhardt et al. 2018; Tiffan et al. 2020). Other studies examine interactions between bass presence and factors such as habitat complexity (Tiffan et al. 2016), potential for competition (Lawrence et al. 2012; Rubenson et al. 2020), and thermal conditions. In particular, thermal conditions may influence current and future degree of spatial overlap, which ultimately drives the potential for species interactions, including predation (Rubenson and Olden 2016; Hawkins et al. 2020). There is no available information on how these processes affect MCR steelhead abundance and productivity.

We are unaware of population estimates or well-documented abundance trends for smallmouth bass within the range of MCR steelhead. However, McMichael (2018) estimated the number of smallmouth bass in a section of McNary Reservoir was nearly 400/km. He reported that most of the smallmouth bass he sampled were in the size range shown to prey heavily on juvenile salmonids (<250 mm FL; Fritts and Pearsons 2006). Though we lack data, it is likely that the smallmouth bass population within the range of MCR steelhead has remained about the same, if not increased over the past five years. For example, the Oregon Department of Fish and Wildlife has documented increased smallmouth bass use of the lower Deschutes River since 2016 (Jason Seals, Fish Biologist, Oregon Department of Fish and Wildlife, personal communication February 2, 2021). We believe it would be less likely for smallmouth bass to be expanding their range if the population was decreasing. We also lack data on the numbers of juvenile steelhead consumed by smallmouth bass. Erring on the side of caution, smallmouth bass predation on juvenile MCR steelhead remains as a threat to MCR steelhead recovery.

There are no population estimates or well-documented abundance trends for walleye within the range of MCR steelhead. McMichael (2018) saw indications that the walleye population from McNary Reservoir upstream to Priest Rapids Dam was relatively abundant and likely increasing in recent years. For example, catch per unit effort for walleye captured by angling in the project area increased substantially between 2011 and 2018 (McMichael 2018). Carpenter et al. (2018) reported that the number of walleye they sampled opportunistically in 2017 was the largest they had recorded since 1990. Dunlap et al. (2018) saw an increase in the walleye catch by fishermen at the John Day Dam, with 846 Walleye caught in 2017 and 517 caught in 2016, compared to a total of 338 Walleye caught at the John Day Dam from 2010 to 2014. Given this information, walleye predation on juvenile MCR steelhead remains as a threat to MCR steelhead recovery.

Channel catfish are established throughout the Columbia River mainstem and are documented predators of juvenile salmonids. Brook trout are the most likely non-native competitor with MCR steelhead in higher elevation streams. No new studies documenting channel catfish predation or brook trout competition impacts were reported in the last five years, and we have no information to be able to quantify their impact on juvenile MCR steelhead survival. Because channel catfish are a warm-water fish, they are likely less active during the MCR steelhead smolt out-migration in spring when the water is still cold, so predation rates are probably low, but they still likely account for some steelhead smolt mortality in the Columbia River migration corridor.

Northern pike are another non-indigenous piscivore with established populations in Lake Roosevelt (Columbia River upstream of Grand Coulee Dam) and some Columbia River tributaries in eastern Washington, including the Pend Oreille and Spokane rivers. Northern pike have not yet been found downstream of Grand Coulee Dam or downstream of Snake River dams. However, northern pike range is likely to increase downstream in the Columbia River, especially if water temperatures get warmer.

In summary, several fish species prey on juvenile salmonids within the Columbia River migration corridor. Although there is an indication that the northern pikeminnow predation rate may have decreased, there are also indications that at least some other predator species populations are increasing (e.g., smallmouth bass, walleye). We are not aware of data that quantifies the predation rates on MCR steelhead specifically. However, due to the number of fish predator species, and the likelihood that some populations are increasing, we believe that juvenile mortality from fish predation remains a factor in limiting the MCR steelhead population.

Listing Factor C Conclusion

We conclude that the risk to the species' persistence because of disease is unknown. There is limited information on disease rates. Fluctuations in disease rates are considered normal, but the current high water temperatures and low water flows associated with climate change effects could exacerbate conditions that could lead to increased disease rates, affecting MCR steelhead.

The limited information available indicates that avian predation rates on juvenile MCR steelhead could be around 15.5 percent in the Columbia River estuary, and potentially 18 percent in the mainstem Columbia River. Total avian predation appears to be a significant factor limiting juvenile MCR steelhead survival.

The most recent information suggests that the pinniped predation rate on MCR steelhead adults remains low, though data is limited. Pinniped predation rate estimates in the estuary are not available for the late summer when MCR steelhead adults are migrating. In the Bonneville tailrace, pinniped presence during adult steelhead migration has increased in the last 6 years, and pinnipeds consumed 1.6 percent of the adult steelhead in the tailrace in 2018. On average pinniped impacts to summer migrating adult MCR steelhead through the lower Columbia River are likely relatively minor because of low pinniped counts at that time, and steelhead are mixed with relatively abundant fall Chinook salmon migrating in September and October.

Several fish species prey on juvenile salmonids within the Columbia River migration corridor. Although data indicates that the northern pikeminnow predation rate has decreased from 8 percent to 6 percent, there are also indications that at least some other predator species' populations are increasing (e.g., smallmouth bass, walleye). We are not aware of data that quantifies the predation rates on MCR steelhead specifically. However, due to the number of fish predator species, and the likelihood that some populations are increasing, we believe that juvenile mortality from fish predation remains a factor in limiting the MCR steelhead DPS.

We therefore conclude that the overall the risk to persistence of the species because of disease/predation is high to moderate with an uncertain trend because of:

- disease rate uncertainty; and
- the combination of avian and fish predation on MCR steelhead juveniles in the Columbia River and estuary posing a major risk to the persistence of MCR steelhead; and
- pinniped predation on adults posing an apparent low risk that needs to be considered because such predation adds to other sources of adult mortality in the Columbia River.

2.3.2.4 Listing Factor D: Inadequacy of Regulatory Mechanisms

Various Federal, state, county and tribal regulatory mechanisms are in place to reduce habitat loss and degradation caused by human use and development such as hydrosystem as well as harvest. For this review, we focus our analysis on regulatory mechanisms for **Habitat** and for **Harvest** that have either improved for MCR steelhead, or that are still causing the most concern in terms of providing adequate protection for MCR steelhead.

Habitat

Habitat concerns are described throughout Listing Factor A as having either a system-wide influence, or more localized influence, on the populations and MPGs that comprise the species. The habitat conditions across all habitat components (tributaries, mainstems, estuary, and marine) necessary to recover listed MCR steelhead are influenced by a wide array of Federal, state, and local regulatory mechanisms. The influence of regulatory mechanisms on listed salmonids and their habitat resources is based in large degree on the underlying ownership of the land and water resources as Federal, state, or private holdings. One factor affecting habitat conditions across all land or water ownerships is climate change, the effects of which are discussed under Section 2.3.2 (*Listing Factor E: Other natural or manmade factors affecting its continued existence*). We reviewed summaries of national and international regulations and agreements governing greenhouse gas emissions, which indicate that while the number and efficacy of such mechanisms have increased in recent years there has not yet been a substantial deviation in global emissions from the past trend, and upscaling and acceleration of far-reaching, multilevel, and cross-sectoral climate mitigation will be needed to reduce future climate-related risks (IPCC 2014, 2018). These findings suggest that current regulatory mechanisms, both in U.S. and internationally, are not currently adequate to address the rate at which climate change is negatively impacting habitat conditions for many ESA-listed salmon and steelhead.

A majority of the Middle Columbia River steelhead DPS habitat is in private ownership (64 percent), with the remaining area under Federal (23 percent), tribal (10 percent) and state (3 percent) ownership. Most of the landscape consists of rangeland and timberland, with significant concentrations of dryland agriculture in the lower portions of major river drainages and irrigated agriculture and urban development generally concentrated in valley bottoms (NMFS 2009).

There are four primary Federal agencies responsible for land and water management in the MCR steelhead DPS: the U.S. Forest Service (USFS), the Bureau of Land Management (BLM), the Bureau of Reclamation (BOR) with a major responsibility for water use in the Yakima and Umatilla subbasins, and the U.S. Army Corp of Engineers (Corps) with a significant role in flood protection.

In the MCR steelhead DPS most of the federally owned lands are high quality headwater habitats vital to the conservation of this DPS, therefore, habitat on Federally owned and Federally managed land is a major recovery priority in several MPGs. Although Federally owned lands (primarily USFS and BLM) make up only 23 percent of the range of MCR steelhead, much of that range is heavily influenced by the BOR operation and management of flows primarily for irrigation in the Yakima and Umatilla subbasins. The BOR water management protocols have resulted in non-normative flow regimes that do not benefit MCR steelhead, but rather adversely affect normal steelhead migration, spawning and rearing behavior. There is uncertainty over the future conservation of MCR steelhead on federally managed river systems and to a lesser extent federally owned land. The level of habitat protection afforded to this DPS and its habitat will be determined by the USFS and BLM land management plans currently under development and by the BOR and Corps management actions.

Regulatory Mechanisms Resulting in Adequate or Improved Protection

New information available since the previous 5-year review indicates that the adequacy of some regulatory mechanisms has improved and has increased protection of MCR steelhead. These include both Federal and state regulatory mechanisms:

1. The Endangered Species Act Section 7 Biological Opinions

1.1 Columbia River System.

Prior to 2019, under the biological opinions for the Columbia River System (CRS) (NMFS 2008, 2014), the U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and Bonneville Power Administration (collectively referred to as the CRS Action Agencies) operated the Columbia River System (formerly referred to as the Federal Columbia River Power System) in accordance with a Reasonable and Prudent Alternative (RPA) that included both operational and non-operational measures expected to minimize project effects and improve the survival of migrating ESA-listed salmon and steelhead (as well eulachon and green sturgeon) and the function of their critical habitat in the Columbia River. Beginning in 2019, the CRS Action Agencies proposed to continue many operational and non-operational measures from the previous RPA but also included mainstem dam operations consistent with a 2019 to 2021 Spill Operation Agreement. A

2019 biological opinion evaluated the effects of that interim proposed action (NMFS 2019b). A 2020 biological opinion evaluated the effects of the CRS Action Agencies' longer-term proposed action, which included increased spill operations intended to improve passage conditions for juvenile salmon, and habitat mitigation intended to improve habitat conditions in the tributaries, as well as in the lower Columbia River estuary (NMFS 2020b).

Improved Juvenile Passage

The CRS Action Agencies proposed increased spring spill levels at many of the mainstem hydroelectric projects with the goal of further improving passage conditions for juvenile salmon and steelhead, thereby reducing the proportion of juveniles passing mainstem dams via turbine units or juvenile bypass systems and thus, potentially increasing adult returns.

Improved Tributary Habitat

Implementation of the tributary habitat program has focused primarily on UCR spring-run Chinook salmon and steelhead and Snake River spring/summer Chinook salmon and Snake River Basin steelhead. Some actions have also been targeted to address Mid-Columbia steelhead. In addition, the CRS Action Agencies formally convened a Tributary Habitat Steering Committee (THSC) and under the 2020 proposed action, a Tributary Technical Team has been formed to provide scientific input on implementation of the program to help ensure that program goals and objectives are achieved.

Improved Floodplain and Estuary Habitat

The CRS Action Agencies are implementing an estuary habitat improvement program (the Columbia Estuary Ecosystem Restoration Program, CEERP), reconnecting the historical floodplain below Bonneville to the mainstem Columbia River. From 2007 through 2019, the Action Agencies implemented 64 projects, including dike and levee breaching or lowering, tide-gate removal, and tide-gate upgrades that reconnected over 6,100 acres of historical tidal floodplain habitat to the mainstem and another 2,000 acres of floodplain lakes (Karnezis 2019; BPA et al. 2020). This represents more than a 2.5 percent net increase in the connectivity of habitats that produce prey used by juvenile Snake River salmon and steelhead (Johnson et al. 2018). In addition to this extensive reconnection effort, about 2,500 acres of currently functioning floodplain habitat have been acquired for conservation.

1.2 Environmental Protection Agency's Registration of Pesticides containing Chlorpyrifos, Diazinon, and Malathion

NMFS (2017) provided the U.S. Environmental Protection Agency (EPA) a Biological Opinion evaluating the effects of the insecticides chlorpyrifos, diazinon, and malathion on Federally listed species and designated critical habitats. The NMFS concluded that chlorpyrifos, diazinon, and malathion are likely to jeopardize several ESA-listed salmonids, including MCR steelhead. Reasonable and Prudent Alternatives (RPAs) include no-spray buffers to reduce spray drift, and vegetated filter strips to reduce surface water run-off around ESA-listed species habitat or water that drains to that habitat. Implementation of the RPA should reduce insecticide loading, and thus MCR steelhead exposure to these insecticides.

2. Clean Water Act

2.1 Section 123 Improvements in Columbia River Basin Restoration Funding

In December 2016, the Congress amended the CWA by adding Section 123, which requires EPA and Office of Management and Budget to take actions related to restoration efforts in the Columbia River Basin. The U.S. Government Accountability Office (GAO) reviewed restoration efforts in the Basin, and in its 2018 report, Columbia River Basin, Additional Federal Actions Would Benefit Restoration Efforts, found that since 2016, the EPA had not yet taken steps to establish the Columbia River Basin Restoration Program, as required by Section 123. EPA did develop a grants program in 2019, and in September of 2020 announced the award of $2 million in 14 grants to tribal, state and local governments, non-profits and community groups throughout the Columbia River Basin. Once these projects are implemented, we anticipate that some will benefit MCR steelhead.

2.2 Temperature Total Maximum Daily Load Requirements

In December 2019 the Ninth Circuit Court of Appeals issued an opinion that the EPA must identify a temperature Total Maximum Daily Load (TMDL) for the Columbia River as neither the State of Washington nor Oregon has provided a temperature TMDL. On May 18, 2020, EPA issued for public review and comment the TMDL for temperature on the Columbia and Lower Snake Rivers. The TMDL addresses portions of the Columbia and lower Snake Rivers that have been identified by the states of Washington and Oregon as impaired due to temperatures that exceed those states' water quality standards. On August 13, 2021, EPA transmitted the re-issued TMDL to the states of Oregon and Washington. Implementation of the TMDL will likely benefit MCR steelhead through improved thermal conditions (e.g., cooler water in summer) in the migratory corridor.

EPA released its final Columbia River Cold Water Refuges Plan on January 7, 2021. The plan focuses on the lower 325 miles of the Columbia River from the Snake River to the ocean. Cold water refuges serve an increasingly important role to some salmon and steelhead species as the Lower Columbia River has warmed over the past 50 years and will likely continue to warm in the future due to climate change. The Columbia River Cold Water Refuges Plan is a scientific document with recommendations to protect and restore cold water refuges. EPA issued this plan in response to consultation under section 7 of the ESA associated with its approval of Oregon’s temperature standards for the Columbia River. This plan also serves as a reference for EPA’s Columbia and Snake Rivers Temperature TMDL.

Harvest

Pursuant to a September 1, 1983, Order of the U.S. District Court, the allocation of harvest in the Columbia River was established under the "Columbia River Fish Management Plan" and implemented in 1988 by the parties of *U.S. v. Oregon*. Since 2008, 10-year management agreements have been negotiated through *U.S. v. Oregon* (NMFS 2008, 2018). Harvest impacts on ESA–listed species in Columbia River commercial, recreational, and treaty fisheries continue to be managed under the 2018-2027 *U.S. v. Oregon* Management Agreement (NMFS 2018). The parties to the agreement are the United States, the states of Oregon, Washington, and Idaho, and the Columbia River Treaty Tribes: Warm Springs, Yakama, Nez Perce, Umatilla, and Shoshone-Bannock. The agreement sets harvest rate limits on fisheries impacting ESA-listed species and these harvest limits continue to be annually managed by the fisheries co-managers (TAC 2015, 2016, 2017, 2018, 2019, 2020). The current *U.S. v. Oregon* Management Agreement (2018-2027) has, on average, maintained reduced impacts of fisheries on MCR steelhead (TAC 2015, 2016, 2017, 2018, 2019, 2020), and we expect that to continue with the abundance-based framework incorporated into the current regulatory regime.

Regulatory Mechanisms Resulting in Inadequate or Decreased Protection

We remain concerned about the adequacy of some existing regulatory mechanisms in terms of supporting the recovery of MCR steelhead. These include regulatory mechanisms with regard to water rights allocation, instream flow rules, and residential wells – each of which reduces available stream volume, flows, limits habitat connectivity, and increases the temperature regime; floodplain management and levees – which constrain floodplain connectivity, riparian conditions, and habitat complexity and habitat forming processes; and the extensive Federal land forest road networks, grazing, and recreation – which erode river banks, introduce sediment load, and impair riparian vegetation and large wood contribution. These concerns, identified in Listing Factor A, fall within the control of Federal and state land and water regulatory mechanisms, described below, and are key threats to MCR steelhead.

1. Clean Water Act

1.1 404 Permits and Nationwide Permits

In 2021, the U.S. Army Corps of Engineers finalized the reissuance of Nationwide Permits (NWPs) with modifications (86 FR 2744, 86 FR 73522). The modification revises several NWPs to remove the 300-linear-foot limit for losses of stream bed. Erring on the side of conservation, NMFS assumes that this will allow for impairment of MCR steelhead habitat, though we have no specific examples indicating that has occurred yet. Traditional 404 permits allow fill in wetlands, streams and rivers, typically creating permanent habitat modifications that limit habitat forming processes, channel migration, and/or riparian vegetation from becoming established.

1.2 Section 404 Permit Exemptions

CWA 404 permit exemptions, particularly those affecting agricultural and transportation activities, continue to promulgate degraded tributary and mainstem habitat conditions. Incorporating measures incentivizing habitat and floodplain functional improvements or mitigation for impacts could provide meaningful habitat improvement for this DPS that are not provided for in the current exemptions.

2. Federal Regulations Affecting Floodplains - The Flood Control Act of 1965, and Public Law 84-99, and the Water Resources Development Act.

2.1 Disconnected Floodplains

Using this trio of authorities, the Corps of Engineers Civil Works program has modified river systems and their floodplains by constructing levees to constrain floods, channelizing rivers, to convey water in simplified systems, dredging gravels and cobbles from rivers to maintain conveyance capacity, and prevent establishment of riparian vegetation, even on levee systems that are no longer Federally-owned. In areas behind "100 year certified" levees, the lands behind are no longer mapped as special flood hazard areas, meaning they can be developed without considering flood risk, per the National Flood Insurance Program's mapping and management standards. Levees constructed primarily to constrain flood waters from reaching land converted to agricultural purpose often ultimately support subsequent intensification of land use, and constraints on river and stream alignment and complexity become permanent.

The Corps' levee management activities, including repairs made under the Flood Control and Coastal Emergency Act (PL 84-99), extend indefinitely the duration of an impaired baseline for floodplain connection and function. However, one of the Corps' own publications reports that "nonstructural alternatives to structural levee rehabilitation" such as levee setbacks, are feasible under PL84-99 (Smith et al. 2017). The Corps also sometimes neglects non-discretionary terms and conditions required under ESA section 7(a)(2) consultation to minimize levee effects to MCR steelhead habitat, such as ensuring levee faces have vegetation to provide some habitat function. Finally, the Corps has not developed programs for the conservation of ESA species per section 7(a)(1) of the ESA to help protect MCR steelhead floodplain habitat.

2.2 Floodplain development

The National Flood Insurance Program (NFIP) is a Federal benefit program that extends access to Federal monies or other benefits, such as flood disaster funds and subsidized flood insurance, in exchange for communities adopting local land use and development criteria consistent with Federally established minimum standards. Under this program, development within floodplains continues to be a concern because it facilitates development in floodplains without mitigation for impacts on natural habitat values.

All West Coast salmon species, including 27 of the 28 species listed under the ESA, are negatively affected by an overall loss of floodplain habitat connectivity and complex channel habitat. The reduction and degradation of habitat has progressed over decades as flood control and wetland filling occurred to support agriculture, silviculture, or conversion of natural floodplains to urbanizing uses (e.g., residential and commercial development). Loss of habitat through conversion was identified among the factors for decline for most ESA-listed salmonids. "NMFS believes altering and hardening stream banks, removing riparian vegetation, constricting channels and floodplains, and regulating flows are primary causes of anadromous fish declines (65 FR 42450)"; "Activities affecting this habitat include…wetland and floodplain alteration; (64 FR 50394)."

Development proceeding in compliance with NFIP minimum standards ultimately results in impacts to floodplain connectivity, flood storage/inundation, hydrology, and to habitat forming processes. Development consequences of levees, stream bank armoring, stream channel alteration projects, and floodplain fill, combine to prevent streams from functioning properly and result in degraded habitat. Most communities (counties, towns, cities) in Washington and Oregon (migratory corridor) are NFIP participating communities, applying the NFIP minimum criteria. For this reason, it is important to note that, where it has been analyzed for effects on salmonids, floodplain development that occurs consistent with the NFIP's minimum standards has been found to jeopardize 18 listed species of salmon and steelhead (Chinook salmon, steelhead, chum salmon, coho salmon, sockeye salmon) (NMFS 2008, 2016a).

The 2016 opinion included Jeopardy and Adverse modification of critical habitat for MCR steelhead (NMFS 2016a). The Reasonable and Prudent Alternative provided in NMFS 2016a has not yet been implemented. Consequently, regulations for floodplain development remain inadequate within the freshwater range of MCR steelhead.

3. Inconsistent State and Local Land Use Planning Regulations

City, county, and state land use planning regulations under the Shoreline Management Act (90.58. RCW) and the Growth Management Act (36.70A RCW) remain inconsistent across the species' range, resulting in growth and development practices that often prevent attaining desired watershed and riparian functions, despite requirements to adopt critical areas ordinances designed to avoid aquifer recharge areas, frequently flooded areas, wetlands, and fish and wildlife habitat conservation areas (RCW 36.70A.030(5)). Development in floodplains continues to be a regional concern as it frequently results in stream bank alteration, stream bank armoring, floodplain fill, and stream channel alteration projects to protect private property that do not allow streams to function properly, resulting in degraded habitat.

4. 90.94 RCW Streamflow Restoration

In January 2018, the Washington state legislature passed the Streamflow Restoration law that helps restore streamflows to levels necessary to support robust, healthy, and sustainable salmon populations while providing water for homes in rural Washington. The State law requires that enough water is kept in streams and rivers to protect and preserve instream resources and values such as fish, wildlife, recreation, aesthetics, water quality, and navigation. One of the most effective tools for protecting streamflows is to set instream flows, which are flow levels adopted into rule. Instream flows cover nearly half of the state's watersheds and the Columbia River. In Washington – and especially on the east side of the state – out-of-stream uses, especially irrigation, exacerbate seasonally low flows, leading to passage and temperature problems, and the loss of habitat living space. Other water uses also play a contributing role, as well as land use (lack of recharge arising from impervious surfaces).

The law is intended to correct effects from the Washington Water Rights – 1917 Water Code and the 1945 Groundwater Act, which govern how much water reaches or remains in streams. The

1917 Water Code is based on the common-law prior appropriations doctrine, and establishes a "first in time, first in rights" allocation for out of stream "beneficial uses" of surface water. Those with adjudicated older "senior" water rights may exert their allocation against junior water right holders in dry years when water supply is low. Beneficial uses did not include leaving water in streams, and many streams are legally allowed to go dry in drought years because senior appropriated amounts may exceed the volume of available water. The 1945 Groundwater Act, as updated in 1973, established a similar senior water rights and permitting system with the growing understanding that subsurface water was hydrologically connected to streams and rivers. Many uses are exempt from permitting requirements, however, including livestock watering, non-commercial lawn or garden watering less than ½ acre, domestic uses and small industrial uses (under 5000 gallons/day). Collectively, the unregulated uses cause a significant cumulative effect on stream recharge, reducing cool water and base flows necessary for summer and early fall survival of listed fish. Some uses of water, particularly during low flow, can have direct impacts to fish, by preventing upstream passage and even survival if water temperatures are too high.

The Washington State Department of Ecology has a list of critical watersheds where instream flows are thought to be a contributing factor to "critical" or "depressed" fish status, as identified by the Washington Department of Fish and Wildlife. There are 16 basins identified as critical, and include Asotin, Garfield, Whitman, Columbia, Walla Walla, Benton, Yakima, Kittitas, Chelan, Pierce, King, Snohomish, Whatcom, Okanogan, and Clallam/Jefferson. Naches, Upper Yakima, Lower Yakima, White Salmon, Klickitat, Rock-Glade, and Walla Walla basins are within the geographic range of MCR steelhead. According to Washington State's instream flow status as of November 2016 (Figure 7), Federal Flow is operative for the Naches, Upper Yakima, and Lower Yakima basins, the Post 2001 Rule is operative in the Walla Walla basin, and there are no instream flow rules operative in the White Salmon, Klickitat, and Rock-Glade basins. No new instream flow requirements have been set for the Washington geography of the bi-state MCR steelhead DPS since the previous 5-year review.

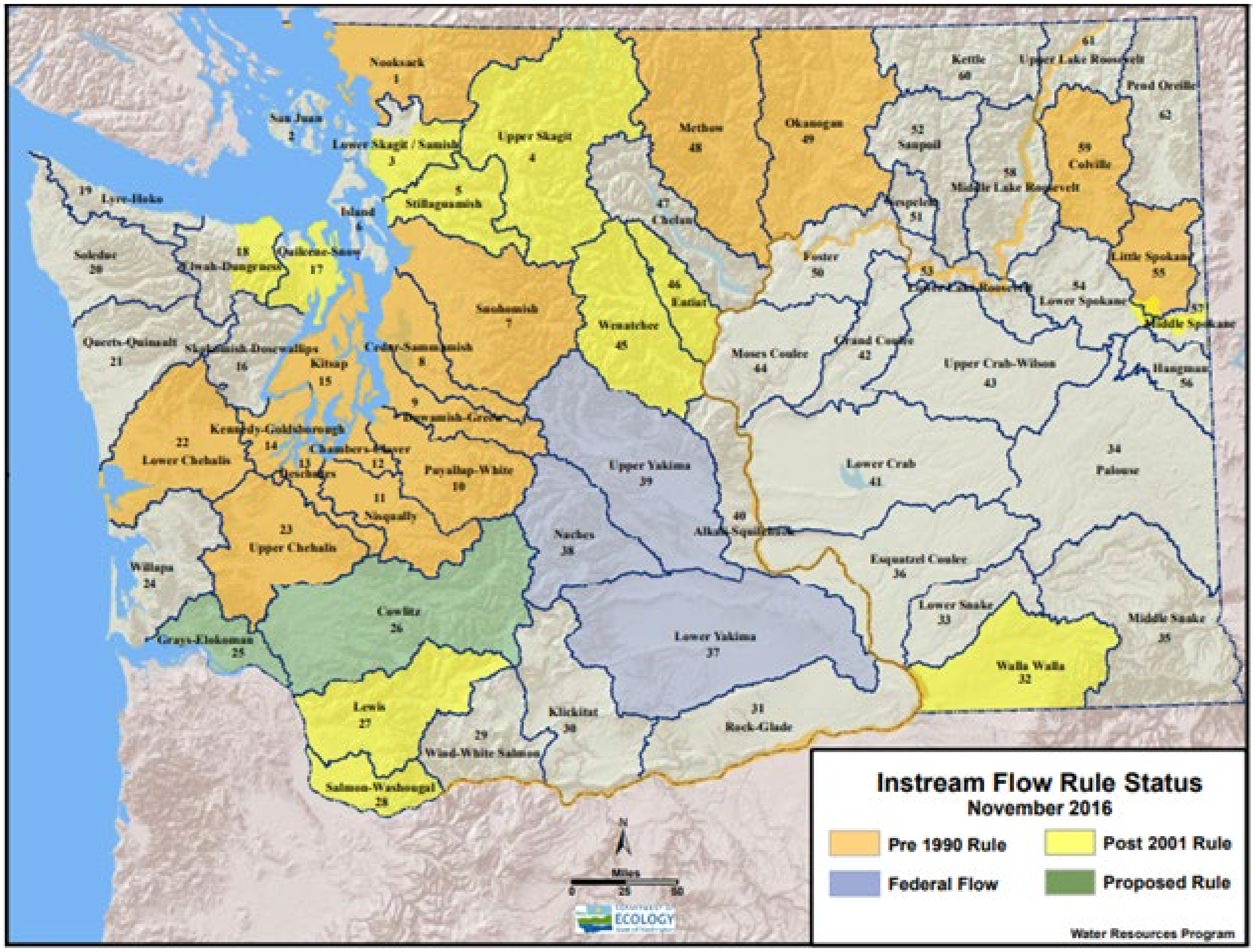

Figure 7. Basins in Washington State with Instream Flow Requirements.

Listing Factor D Conclusion

Based on the information noted above, we conclude that despite potential improvements in some regulatory arenas, there continues to be a moderate to high risk to MCR steelhead persistence because of the inadequacy of existing regulatory mechanisms. New regulatory mechanisms since the 2016 5-year review have the potential to improve MCR steelhead conservation, such as flexible spill operations on the Columbia River System, and the Cold Water Refuges Plan by the EPA. However, several on-going regulatory issues continue to hinder MCR steelhead recovery, such as the PL 84-99 levee program, the NFIP, and water allocations.

Recommended Actions

- Implement Columbia River Cold Water Refuges Plan recommendations to protect and restore cold water refuges.
- Implement alternative strategies for levee repair and replacements including levee removal and setbacks, levee softening, or placing more complex habitat and vegetation.
- Implement changes to the NFIP program to minimize and mitigate floodplain fill that

result in loss of functioning MCR steelhead habitat.

- Incorporate measures incentivizing habitat and floodplain functional improvements that provide meaningful habitat improvement that are not provided for in the current CWA Section 404 permit exemptions.

2.3.2.5 Listing Factor E: Other natural or manmade factors affecting the continued existence of the species

Other natural or manmade factors affecting the continued existence of this species include:

- Climate change.
- Ocean conditions and marine survival.
- Rearing and migration habitat conditions in the Lower Columbia River estuary.
- Hatcheries.

Climate Change

One factor affecting the rangewide status of MCR steelhead and aquatic habitat is climate change. Major ecological realignments are already occurring in response to climate change (Crozier et al. 2019). As observed by Siegel and Crozier in 2019, long-term trends in warming have continued at global, national and regional scales. The five warmest years in the 1880 to 2019 record have all occurred since 2015, while 9 of the 10 warmest years have occurred since 2005 (Lindsey and Dahlman 2020). The year 2020 was another hot year in national and global temperatures; it was the second hottest year in the 141-year record of global land and sea measurements, and capped off the warmest decade on record (http://www.ncdc.noaa.gov/sotc/global202013). Events such as the 2013-2016 marine heatwave (Jacox et al. 2018), have been attributed directly to anthropogenic warming in the annual special issue of Bulletin of the American Meteorological Society on extreme events (Herring et al. 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality. These two factors are often examined in isolation, but likely have interacting effects on ecosystem function (Siegel and Crozier 2019). Conservation strategies now need to account for geographical patterns in traits sensitive to climate change, as well as climate threats to species-level diversity.

Climate change has negative implications for MCR steelhead survival and recovery, and for their designated critical habitat (Climate Impacts Group 2004; Scheuerell and Williams 2005; Zabel et al. 2006; ISAB 2007), characterized by the ISAB as follows:

- Warmer air temperatures will result in diminished snowpack and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a smaller snowpack, watersheds will see their runoff diminished earlier in the

season, resulting in lower stream flows in June through September. Peak river flows, and river flows in general, are likely to increase during the winter due to more precipitation falling as rain rather than snow.

- Water temperatures are expected to rise, especially during the summer months when lower stream flows co-occur with warmer air temperatures. Islam et al. (2019) found that air temperature accounted for about 80 percent of the variation in stream temperatures in the Fraser River, thus tightening the link between increased air and water temperatures.

These changes will not be spatially homogenous across the entire Pacific Northwest. Low-lying areas are likely to be more affected. Climate change may have long-term effects that include, but are not limited to, depletion of important cold-water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, earlier emergence of fry, and increased competition among species.

Impacts on Salmon

Range of effects caused by a changing climate

Climate change is predicted to cause a variety of impacts to Pacific salmon and their ecosystems (Mote et al. 2003; Crozier et al. 2008; Martins et al. 2012; Wainwright and Weitkamp 2013; OCCRI 2019, 2021). The complex life cycles of anadromous fishes, including salmon, rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation. Ultimately, the effects of climate change on salmon and steelhead across the Columbia Basin will be determined by the specific nature, level, and rate of change and the synergy among interconnected terrestrial/freshwater, estuarine, nearshore, and ocean environments. Climate change and anthropogenic factors continue to reduce adaptive capacity in Pacific salmon as well as altering life history characteristics and simplifying population structure.

The primary effects of climate change on Pacific Northwest salmon and steelhead are (Crozier 2016; Crozier et al. 2021):

- Direct effects of increased water temperatures on fish physiology and increased susceptibility to disease.
- Temperature-induced changes to stream flow patterns which can block fish migration, trap fish in dewatered sections, dewater redds, introduce non-native fish, and degrade water quality.
- Alterations to freshwater, estuarine, and marine food webs, which alter the availability and timing of food resources.
- Changes in estuarine and ocean productivity, which have changed the abundance and productivity of fish resources.

Effects caused by changing flows and temperatures

While all habitats used by Pacific salmon will be affected, the impacts and certainty of the change vary by habitat type. Some effects (e.g., increasing temperature) affect salmon at all life stages in all habitats, while others are habitat-specific, such as stream-flow variation in freshwater, sea-level rise in estuaries, and upwelling in the ocean. How climate change will affect each stock or population of salmon also varies widely depending on the level or extent of change, the rate of change, and the unique life history characteristics of different natural populations (Crozier et al. 2008). For example, a few weeks difference in migration timing can have large differences in the thermal regime experienced by migrating fish (Martins et al. 2011). This occurred in 2015, when about 475,000 adult sockeye salmon (all ESUs) passed Bonneville Dam in the Columbia River, but only 2 to 15 percent of these adult sockeye, depending upon the population, survived to their spawning grounds. Most died in the lower Columbia River beginning in June when the water warmed to above 68°F, the temperature at which sockeye salmon begin to die. Water temperatures rose to 73°F in July, when the area experienced a combination of continued high summer temperatures and lower than average flows (due to the lower snowpack from the previous winter and drought conditions exacerbated due to increased occurrences of warm weather patterns) (NMFS 2016b). In 2015, only 14 percent of adult SR sockeye salmon survived from Bonneville to McNary Dam, and only 4 percent survived from Bonneville to Lower Granite Dam (NMFS 2016b).

Like most fishes, salmon are poikilotherms (cold-blooded animals); therefore, increasing temperatures in all habitats can have pronounced effects on their physiology, growth, and development rates (see review by Whitney et al. 2016). Increases in water temperatures beyond their thermal optima will likely be detrimental through a variety of processes, including increased metabolic rates (and therefore food demand), decreased disease resistance, increased physiological stress, and reduced reproductive success. All of these processes are likely to reduce fitness of salmonids, including MCR steelhead (Beechie et al. 2013; Wainwright and Weitkamp 2013; Whitney et al. 2016).

By contrast, increased temperatures at ranges well below thermal optima (i.e., when the water is cold) can increase growth and development rates. Examples of this include accelerated emergence timing during egg incubation stages, or increased growth rates during fry stages (Crozier et al. 2008; Martins et al. 2011). Temperature is also an important behavioral cue for migration (Sykes et al. 2009), and elevated temperatures may result in earlier-than-normal migration timing. While there are situations or stocks where this acceleration in processes or behaviors is beneficial, there are others where it is detrimental (Sykes et al. 2009; Whitney et al. 2016).

How precipitation and snowpack changes will affect freshwater ecosystems largely depends on their specific characteristics and location (Crozier et al. 2008; Martins et al. 2012). For example, within a relatively small geographic area (the Salmon River basin in Idaho), survival of some Chinook salmon populations was shown to be determined largely by temperature, while in others it was determined by flow (Crozier and Zabel 2006; Isaak et al. 2018). Certain salmon populations inhabiting regions that are already near or exceeding thermal maxima will be most affected by further increases in temperature and, perhaps, the rate of the increases, while the effects of altered flow are less clear and likely to be basin-specific (Crozier et al. 2008; Beechie et al. 2013; Isaak et al. 2018). However, river flow is likely to become more variable in many rivers and is believed to negatively affect anadromous fish survival more than other environmental parameters (Ward et al. 2015). It is likely that this increasingly variable flow is detrimental to salmon and steelhead populations in the Columbia River basin.

The effects of climate change on stream ecosystems are difficult to predict (Lynch et al. 2016). Changes in stream temperature and flow regimes are likely to lead to shifts in the distributions of native species and facilitate establishment of exotic species. This will result in novel species interactions, including predator-prey dynamics, where juvenile native species may be either predators or prey (Lynch et al. 2016; Rehage and Blanchard 2016). How juvenile native species will fare as part of "hybrid food webs," which are constructed from native, native invaders, and exotic species, is difficult to predict (Naiman et al. 2012).

New Information

The last 5-year review (NMFS 2016a) summarized the best available science on how climate change is predicted to impact freshwater environments, estuarine and plume environments, marine conditions and marine survival, the consequences of marine conditions, and drought management. The current best available science supports that previous analysis. The discussion below updates new information as it relates to how climate change is currently impacting and predicted to impact MCR steelhead in the future.

Marine Effects

Siegel and Crozier (2020) summarized new science published in 2019 with a number of publications describing the anomalous conditions of the marine heatwave that led to an onshore and northward movement of warm stratified waters into the California Current ecosystem off of the west coast of the U.S. Brodeur et al. (2019) described the community response of the plankton community composition and structure, suggesting that forage fish diets had to shift in response to food resources that are considerably less nutritionally dense. This was supported by the work of Morgan et al. (2019) who stated that it was unclear whether these observations represented an anomaly or were a permanent change in the Northern California Current.

Crozier et al. (2019) asserted in their vulnerability analysis (see below) that sea surface temperature and ocean acidification (as well as freshwater stream temperatures) were the most broadly identified climate-related stressors likely to impact populations.

Groundwater Effects

The effect of climate change on groundwater availability is likely to be uneven. Sridhar et al. (2018) coupled a surface-flow model with a ground-flow model to improve predictions of surface water availability with climate change in the Snake River basin. Combining the VIC and MODFLOW models (VIC-MF), they predicted flow for 1986-2042. Comparisons with historical data show improved performance of the combined model over the VIC model alone. Projections using RCP 4.5 and 8.5 emission scenarios suggested an increase in water table heights in downstream areas of the basin and a decrease in upstream areas. Such assessments will help stakeholders manage water supplies more sustainably, but ultimately will likely make it more challenging for populations returning to spawn in late summer and early fall like MCR steelhead where low flows are already a constraint. In support of that idea, Leach and Moore (2019) found that groundwater may only make streams resistant to change in the short term as groundwater sources will be impacted on longer time scales.

Freshwater Effects

As cited in Siegel and Crozier (2019), Isaak et al. (2018) examined recent trends in stream temperature across the western United States using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of 1996-2015 (0.18-0.35°C/decade) and 1976-2015 (0.14-0.27°C/decade). Their results show how continued warming will likely affect the cumulative temperature exposure of migrating salmon. Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm.

Streams with intact riparian corridors and that lie in mountainous terrain are likely to be more resilient to changes in air temperature. These areas may provide refuge from climate change for a number of species, including Pacific salmon. Krosby et al. (2018) identified potential stream refugia throughout the Pacific Northwest based on a suite of features thought to reflect the ability of streams to serve as such refuges. Analyzed features include large temperature gradients, high canopy cover, large relative stream width, low exposure to solar radiation, and low levels of human modification. They created an index of refuge potential for all streams in the region, with mountain area streams scoring highest. Flat lowland areas, which commonly contain migration corridors, were generally scored lowest, and thus were prioritized for conservation and restoration. These low-lying habitats provide important juvenile rearing habitat, thus their continued value (without restoration) as rearing habitat in the near term is a concern.

Siegel and Crozier (2019) point out concern that for some salmon populations, climate change may drive mismatches between juvenile arrival timing and prey availability in the marine environment. However, phenological diversity can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch. Carr-Harris et al. (2018) explored phenological diversity of marine migration timing in relation to zooplankton prey for sockeye salmon from the Skeena River of Canada. They found that sockeye migrated over a period of more than 50 days. Populations from higher elevation and further inland streams arrived in the estuary later, and different populations encountered distinct prey fields. They recommended that managers maintain and augment such life-history diversity. MCR steelhead exhibit some phenological diversity but whether it is enough to buffer the effects of climate change is not known.

A concern that affects the recovery of MCR steelhead is high water temperatures in the adult migration corridor. As described above, high water temperatures in 2015 resulted in catastrophic pre-spawning mortalities for SR sockeye salmon. Conditions that lead to high water temperatures are predicted to occur more frequently in the future with climate change. Anttila et al. (2019) suggest that migration conditions act as a strong selective force on cardiac capacity in sockeye salmon populations, as measured by sacrco(endo)plasmic reticulum Ca2+-ATPase activity (SERCA). They found that SERCA differs considerably across populations, and related these differences to the adult migratory experience of populations, with those that migrated to high elevations and experiencing higher temperatures have larger capacities. The implication for MCR steelhead is not known at this time.

Marine Survival

Variation in marine productivity and prey quality can greatly impact the marine survival of salmon populations. The specific ocean habitat use of different salmon populations is poorly defined. Recent work by Espinasse et al. (2019) used carbon and nitrogen stable isotopes derived from an extensive time-series of salmon scales to examine aspects of the marine environment used by Rivers Inlet (British Columbia) sockeye salmon. The authors were able to identify likely rearing areas before sampling. This work as well as other research cited in Siegel and Crozier (2020) are improving our understanding of how marine productivity impacts salmon growth and survival, particularly during the early marine period.

Siegel and Crozier (2019) observe that changes in marine temperature are likely to have a number of physiological consequences on fishes themselves. For example, in a study of small planktivorous fish, Gliwicz et al. (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey. Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz et al. (2018) suggest that ambient temperatures can have a similar effect on fish that do not demonstrate this trait. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay et al. 2018). Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux et al. 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

Climate Vulnerability Assessment

Crozier et al. (2019) recently completed a climate vulnerability assessment for Pacific salmon and steelhead, including MCR steelhead. The assessment was based on three components of vulnerability: (1) biological sensitivity, which is a function of individual species characteristics; (2) climate exposure, which is a function of geographical location and projected future climate conditions; and (3) adaptive capacity, which describes the ability of a DPS to adapt to rapidly changing environmental conditions. Objectives were to characterize the relative degree of threat posed by each component of vulnerability across DPSs and to describe landscape-level patterns in specific threats and cumulative vulnerability at the DPS level. Refer to Crozier et al. (2019) for more information on the methodology they used to calculate climate vulnerability for each DPS.

Crozier et al. (2019) concluded that the MCR steelhead DPS has a high risk of overall climate vulnerability based on its high risk for biological sensitivity, high risk for climate exposure, and moderate capacity to adapt. The adult freshwater stage was rated the most highly vulnerable life stage due to high summer stream temperatures. MCR steelhead scored moderate in adaptive capacity due to habitat loss and degradation. The use of LCMs in the future will help us better plan for climate change by identifying those parts of the life cycle will most benefit from improved resilience.

Lower Columbia River Estuary Modifications

The Lower Columbia River estuary provides important migratory habitat for juvenile salmonids. Since the late 1800s, about 70 percent of the vegetated tidal wetlands of the Columbia River estuary have been lost to diking, filling, and bank hardening, combined with flow regulation and other modifications (Kukulka and Jay 2003; Bottom et al. 2005; Marcoe and Pilson 2017; Brophy et al. 2019). Disconnection of tidal wetlands and floodplains has reduced the production of wetland macrodetritus supporting the food web (Simenstad et al. 1990; Maier and Simenstad 2009), both for small Chinook and chum salmon that rear in shallow water and for larger juvenile salmonids which migrate in the mainstem (PNNL and NMFS 2020).

Restoration actions in the estuary have improved habitat quality and fish access to floodplain forests and wetlands. From 2007 through 2019, the Bonneville Power Administration and U.S. Army Corps of Engineers (Corps) implemented 64 projects that included dike and levee breaching or lowering, tide-gate removal, and tide-gate upgrades. These have reconnected over 6,100 acres of the historical floodplain to the mainstem Columbia River and another 2,000 acres of floodplain lakes (Karnezis 2019; BPA et al. 2020). This represents more than a 2.5 percent net increase in the connectivity of habitats that produce prey used by juvenile salmonids (Johnson et al. 2018). In addition to this extensive reconnection effort, the Bonneville Power Administration and Corps have acquired conservation easements to protect about 2,500 acres of currently functioning floodplain habitat from development. Numerous other project sponsors have completed floodplain protection and restoration projects in the Lower Columbia River.

Floodplain habitat restoration affects the performance of juvenile salmonids whether they move onto the floodplain or stay in the mainstem. Wetland food production supports foraging and growth within the wetland (Johnson et al. 2018), but the prey items produced in wetlands (primarily chironomid insects and corophiid amphipods) (PNNL and NMFS 2018, 2020) are also exported to the mainstem and off-channel habitats behind islands and other landforms, where they become available to salmon and steelhead migrating in these locations. Juvenile steelhead, including MCR steelhead, moving through the mainstem or off-channel habitats behind islands and other landforms then have access to these food items. Thus, while most steelhead may not enter a tidal wetland channel, they can still derive benefits from wetland habitats.

Middle Columbia River steelhead juveniles that feed on prey exported to the mainstem from wetlands may have improved survival at ocean entry. For example, blood serum levels of IGF-1 (Insulin-like growth factor-1) for yearling steelhead (DPS not specified) collected in the estuary were higher than are typically found in hatchery fish before release, suggesting that prey quality and quantity in the estuary were sufficient for growth (PNNL and NMFS 2020). However, variation in IGF-1 levels was substantial (two to three times higher in some individuals than in others) (Beckman 2020), both within and between genetic stocks, indicating differences in feeding and migration patterns. Continuing to grow during estuary transit may be part of a strategy to escape predation during the ocean life stage through larger body size.

Hatchery Effects

The effects of hatchery fish on the status of an ESU or DPS depends upon which of the four key attributes – abundance, productivity, spatial structure, and diversity – are currently limiting the ESU/DPS, and how the hatchery fish within the ESU/DPS affect each of the attributes (70 FR 37204). Hatchery programs can provide short-term demographic benefits such as increases in abundance during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks to natural productivity and diversity. The magnitude and type of the risk depends on the status of affected populations and on specific practices in the hatchery program.

In general, hatchery programs can provide short-term demographic benefits to salmon and steelhead, such as increases in abundance during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks to natural productivity and diversity. The magnitude and type of risk depends on the status of affected populations and on specific practices in the hatchery program. Hatchery programs can affect naturally produced populations of salmon and steelhead in a variety of ways, including competition (for spawning sites and food) and predation effects, disease effects, genetic effects (e.g., outbreeding depression, hatchery-influenced selection), broodstock collection effects (e.g., to population diversity), and facility effects (e.g., water withdrawals, effluent discharge) (NMFS 2018).

The proportions of hatchery-origin returns in natural spawning areas varies between the MPGs within the MCR steelhead DPS, with low proportions observed in the Yakima and John Day River MPGs, and larger proportions in the Umatilla/Walla Walla and Cascades Eastside Slope Tributaries MPGs (NWFSC 2015). The management of the fish being propagated at the various programs (Table 5) has changed recently to focus production on individual populations using only fish from within that population (NMFS 2007, 2008, 2017, 2018, 2019b).

Out-of-DPS hatchery strays may pose a risk to some Oregon MCR steelhead populations, particularly the Eastside and Westside Deschutes and John Day populations. An assessment by Keefer et al. (2016) identified that a significant proportion of spawners in the Deschutes River and John Day River populations were out-of-DPS strays. However, they also noted that some out-of-basin steelhead migrating into the Deschutes River appeared to be seeking thermal refugia and eventually returned to their natal streams (Keefer et al. 2016). NMFS' 2016 5-year review noted a decrease in the proportion of strays in the John Day River basin and identified a need for additional information to assess the effects of hatchery strays on natural production in the Deschutes River and John Day River systems (NMFS 2016a).

Genetic sampling has documented that the Rock Creek steelhead population is highly introgressed with the Snake River Basin steelhead DPS (85 percent of adult PIT-tag detections with known juvenile origin were of Snake River origin). With additional data, it should become apparent if steelhead in Rock Creek are a viable naturalized subpopulation or are sustained by an annual influx of stray steelhead originating from the Snake River (Conley 2015; NWFSC 2015). Snake River steelhead transport rates have decreased as a result of earlier migrations and higher spill, and transported Snake River steelhead are known to stray at higher rates than fish that migrated in-river as juveniles.

Hatchery programs operated in middle Columbia tributaries – including the Umatilla, Walla Walla, and Westside Deschutes River subbasins – also create some risks due to ecological interactions and genetic introgression. For hatchery programs that incorporate sufficient natural-origin adults into the broodstock or were derived from the endemic population, NMFS has determined that fish produced therein have not changed substantially or displayed a level of genetic divergence from the local population that is greater than the divergence among closely related natural populations within the DPS (85 FR 81822). The Umatilla River summer steelhead and the Touchet River endemic summer steelhead (Walla Walla Basin) programs currently incorporate natural-origin adults into the broodstock (NMFS 2019c), and the Round Butte Hatchery summer steelhead program (Deschutes River) is proposing to incorporate natural-origin adults into the broodstock and is currently in an ESA Section 7 consultation.

Collections for the Yakima River Kelt Reconditioning Program are made at the Chandler Juvenile Monitoring Facility, where approximately 20 percent of the outmigrating, post-spawn steelhead are collected in the spring and then transported to Prosser Hatchery for reconditioning using the methods described by Trammell et al. (2016). After 6 months, the consecutive spawners are released both above and below Prosser Dam when the Upper Columbia River steelhead run is returning from the ocean. The reconditioned and released fish proceed to over-winter locations with the rest of the Yakima River populations, and to spawning grounds in the spring (Hatch et al. 2018).

From 2000 to 2017, the number of kelt steelhead collected by the Yakima River Program has ranged from 118 to 1,157 fish per year. Of these fish, at least 22 percent and up to 76 percent have been successfully reconditioned and released (the largest number of fish released was 404 in 2010). Since 2009, estradiol levels have been measured in the female kelts to determine whether they will be ready to spawn in the spring. The number of known mature females released by the program as consecutive spawners has ranged between 56 and 382 per year from 2009 to 2017, with an average of 175 per year. Since 2013, the program has retained females with low estradiol levels for an additional year of reconditioning. This method has successfully added an additional 8 to 37 (19 on average) "skip spawner" female kelts to the annual releases (Hatch et al. 2018)

NMFS has consulted on all the steelhead hatchery programs in the middle Columbia River basin, with the exception of the Round Butte summer steelhead hatchery program, for which an ESA Section 7 consultation is in progress. In all the completed consultations. NMFS has concluded that the programs are not likely to appreciably reduce the likelihood of survival and recovery of the MCR steelhead listed DPS (NMFS 2007, 2008, 2017, 2018, 2019b).

Table 5. ESA Status of hatchery programs within the MCR Steelhead DPS; HGMP = Hatchery and Genetic Management Plan; C = Review under the ESA is complete; U = undergoing ESA review.

Program Stock Origin	Program	Run	Watershed Location of Release (State)	Currently Listed?	HGMP/TRMP Status
Yakima River	Yakima River Kelt Reconditioning	Summer	Yakima River (WA)	Yes	C
Touchet River	Touchet Endemic	Summer	Touchet River (WA)	Yes	C
Umatilla River	Umatilla River	Summer	Umatilla River (WA)	Yes	C
Wallowa	Walla Walla	Summer	Walla Walla River (WA)	No	C
Deschutes River	Deschutes River	Summer	Deschutes River (OR)	Yes	U
Skamania	Klickitat River	Summer	Klickitat River (WA)	No	C

Listing Factor E Conclusion

Current information indicates that climate change will continue, and the effects to salmon and steelhead will increase. MCR steelhead have a high vulnerability to climate change, and the adult freshwater life-stage is especially sensitive to high summer stream temperatures. With expected diminished snowpacks, lower June through September stream flows, and higher summer water temperatures, climate change will have negative implications for MCR steelhead survival and recovery into the future. Overall, since the previous 5-year review, there is an increasing trend from moderate to high risk of climate change to the persistence of MCR steelhead.

The effects of ocean conditions on MCR steelhead marine survival are poorly understood. Variation in marine productivity, prey quality, and sea surface temperature likely play a role in marine survival, and are influenced by climate change and natural climatic variability. Although restoration actions in some areas of the Lower Columbia River Estuary have improved salmon and steelhead habitat quality and juvenile access to floodplain wetlands, about 70 percent of the vegetated tidal wetlands of the estuary have been lost. Overall, since the previous 5-year review, there remains an uncertain variable moderate to high risk of ocean and Lower Columbia River estuary conditions to the persistence of MCR steelhead.

Out-of-DPS hatchery strays may pose a risk to some Oregon MCR steelhead populations, particularly the Eastside and Westside Deschutes and John Day populations. Hatchery programs operated in middle Columbia River tributaries also create some risks due to ecological interactions and genetic introgression. However, since the previous 5-year review, an increasing number of hatchery programs now incorporate natural-origin adults into the broodstock. Overall, since the previous 5-year review, the moderate risk of hatcheries to the persistence of MCR steelhead has remained unchanged.

We conclude that climate change, ocean conditions and marine survival, the impaired status of the Lower Columbia River estuary, and hatcheries remain as major risk factors to MCR steelhead recovery, with climate change and ocean conditions posing an increasing risk to the persistence of MCR steelhead.

2.4 Synthesis

The ESA defines an endangered species as one that is in danger of extinction throughout all or a significant portion of its range, and a threatened species as one that is likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range. Under ESA section 4(c)(2), we must review the listing classification of all listed species at least once every five years. While conducting these reviews, we apply the provisions of ESA section 4(a)(1) and NMFS' implementing regulations at 50 CFR part 424.

To determine if a reclassification is warranted, we review the status of the species and evaluate the five risk factors, as identified in ESA section 4(a)(1): (1) the present or threatened destruction, modification, or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; and (5) other natural or man-made factors affecting a species' continued existence. We then make a determination based solely on the best available scientific and commercial information, taking into account efforts by states and foreign governments to protect the species.

- ***Updated Biological Risk Summary***: Our Northwest Fisheries Science Center completed an updated viability review for the DPS (Ford 2022). There has been functionally no change in the viability ratings for the component populations, and the MCR steelhead DPS does not currently meet the viability criteria described in the Middle Columbia

River Steelhead Recovery Plan (NMFS 2009). Updated information indicates that stray levels into the John Day River populations have decreased in recent years. Out of basin hatchery stray proportions, although reduced, remain high in spawning reaches within the Deschutes River basin and the Walla Walla, Umatilla and Touchet populations. In general, the majority of population level viability ratings remained unchanged from the previous 5-year review and the recent risk trend summarizing the overall trends in risk status for the DPS since the prior status review remains stable/improving at a moderate risk level (Ford 2022).

- ***Listing Factor A (Habitat):*** New information since the last 5-year review indicates there is improvement in freshwater and estuary habitat conditions for MCR steelhead spawning, rearing, and migration in some locations. In particular, the construction of a fish ladder at Opal Springs Dam gave steelhead access to 125 miles of habitat in the Crooked River drainage (Cascades Eastern Slope Tributaries MPG), and removal of the final barrier on Manastash Creek (Yakima River MPG), opened access to more than 20 miles of new tributary habitat. Improvements to fish passage and numerous tributary habitat restoration and enhancement projects involving large wood supplementation, floodplain reconnection, riparian fencing and replanting, and work with property owners to increase water conservation and summer flows should result in improved survival for this DPS.

  However, widespread areas of degraded or inaccessible habitat continue to persist for all four MPG's due to: (1) dams and irrigation infrastructure; (2) low summer flows and high summer water temperatures; (3) disconnected floodplains; and (4) loss of riparian function. Other factors pertain to some MPG's more than others, such as grazing effects in the John Day River MPG, and levees in the Walla Walla and Umatilla Rivers and in the Yakima River MPG's. Finally, the effects of increasing floodplain development and other anthropogenic factors likely offset at least some restoration benefits, but are not well documented or quantified. There remain numerous opportunities for habitat restoration or protection throughout the range of this DPS. Additional priority recovery actions and best management practices that apply to all populations and protect the highest quality habitats and conserve ecological processes that support population viability are necessary to bring this DPS to viable status. Future 5-year assessments would benefit from a systematic review and quantitative analysis of the amount of habitat addressed versus the priority watershed reaches targeted for protection and restoration activities in the 2009 recovery plan in order to track progress against plan objectives.

  We therefore conclude that there is a moderate to high risk to the MCR steelhead DPS persistence because of habitat destruction or modification. Our conclusion is based on the fact that extensive miles of stream remain inaccessible or unsuitable for steelhead, many legacy habitat threats continue, and threats from on-going development remain.

- ***Listing Factor B (Overutilization):*** Harvest and research/monitoring sources of mortality remain low, continuing to have little to no impact on the recovery of the MCR steelhead

DPS. Thus, the risk to the species' persistence because of overutilization remains low and unchanged since the 2016 5-year review.

- ***Listing Factor C (Disease and Predation):*** We therefore conclude that the overall the risk to persistence of the species because of disease/predation is moderate to high with an uncertain trend because of:
    - disease rate uncertainty;
    - the combination of avian and fish predation on MCR steelhead juveniles in the Columbia River and estuary posing a major risk to the persistence of MCR steelhead; and
    - pinniped predation on adults posing an apparent low risk that needs to be considered because such predation adds to other sources of adult mortality in the Columbia River.
- ***Listing Factor D (Regulatory Mechanisms):*** Despite potential improvements in some regulatory arenas, there continues to be a moderate to high risk to MCR steelhead persistence because of the inadequacy of existing regulatory mechanisms. New regulatory mechanisms since the 2016 5-year review have the potential to improve MCR steelhead conservation, such as flexible spill operations on the Columbia River System, and the Cold Water Refuges Plan by the EPA. However, several on-going regulatory issues continue to hinder MCR steelhead recovery, such as the PL 84-99 levee program, the NFIP, and water allocations.
- ***Listing Factor E (Other Natural and Manmade Factors):*** Climate change, ocean conditions and marine survival, the impaired status of the Lower Columbia River Estuary, and hatcheries remain as major risk factors to MCR steelhead recovery, with climate change and ocean conditions posing an increasing risk to the persistence of MCR steelhead.

After considering the biological viability of the MCR DPS and the current status of its ESA section 4(a)(1) factors, we conclude that the status of the MCR steelhead DPS has not improved significantly since the final listing determination in 2006. The implementation of sound management actions in hydropower, habitat, hatcheries, and harvest are essential to the recovery of the MCR DPS and must continue. The biological benefits of habitat restoration and protection efforts, in particular habitat restoration, have yet to be fully expressed and will likely take another ten to 40 years to result in measurable improvements to population viability. By continuing to implement actions that address the factors limiting population survival and monitoring the effects of the actions over time, we will ensure that restoration efforts meet the biological needs of each population and, in turn, contribute to the recovery of these species. The 2009 MCR recovery plan and updated prioritization strategy (Mid-C Forum 2018) provide the primary guidelines for identifying future actions to target and address MCR steelhead limiting factors and threats. Over the next five years, it will be important to continue to implement these actions and monitor our progress.

2.4.1 Middle Columbia River Steelhead Delineation and Hatchery Membership

The Northwest Fisheries Science Center's review (Ford 2022) found that no new information had become available that would justify a change in the delineation of the MCR steelhead DPS.

The West Coast Regional Office's 2022 review of new information since the previous 5-year review regarding the DPS membership status of various hatchery programs indicates that the Yakima River Kelt Reconditioning Program that is currently included in the MCR steelhead DPS should be removed to be consistent with other programs in the Columbia River basin that recondition summer steelhead kelts and because kelt reconditioning is not considered a hatchery program compared to the other programs that are included in the DPS. Kelts are adult steelhead that have completed spawning and are migrating downstream to the ocean, where, if they survive, can return to spawn again (i.e., repeat spawners). However, kelts from the basins above multiple mainstem dams do not survive to become repeat spawners due to poor out-migration survival past the dams. The kelt reconditioning programs collect these post-spawning adult steelhead as they migrate from the spawning grounds, and then hold and feed them for a number of months before releasing them back into their natal river to spawn naturally.

2.4.2 ESU/DPS Viability and Statutory Listing Factors

- The information presented in the Northwest Fisheries Science Center's review of updated information (Ford 2022) suggests no change in the biological risk category for the MCR steelhead since the time of the last status review (NMFS 2015).
- Our analysis of the ESA section 4(a)(1) factors indicates that the collective risk to the MCR steelhead's persistence has remained the same since our previous 5-year review.

3. Results

3.1 Classification

Listing status:

Based on the information identified above, we determine that no reclassification for the MCR steelhead DPS is appropriate, and therefore:

- The MCR steelhead DPS should remain listed as threatened.

ESU/DPS delineation:

The Northwest Fisheries Science Center's review (Ford 2022) found that no new information has become available that would justify a change in the delineation of the MCR steelhead DPS.

Hatchery membership:

For the MCR steelhead DPS, we recommend removal of the Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River) from the DPS for the reasons explained above. The addition or removal of an artificial propagation program from a DPS delineation does not constitute a change in the listing status of the DPS but is a revision to the composition of the listed DPS based on the best available scientific information.

3.2 New Recovery Priority Number

Since the previous 2016 5-year review, NMFS revised the recovery priority number guidelines and twice evaluated the numbers (NMFS 2019a, 2022). Table 4 indicates the numbers in place at the beginning of the current review. In January 2022, the number was changed to 3C for the MCR steelhead DPS (NMFS 2022).

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4. Recommendations for Future Actions

In our review of the listing factors, we identified several actions critical to improving the status of the MCR steelhead DPS. The most important actions to be taken over the next 5 years include implementation of the high priority strategies and actions identified in the 2009 Middle Columbia River Recovery Plan (NMFS 2009), the *U.S. v. Oregon* (in-river harvest) Management Agreement for years 2018-2027, the 2020 Columbia River System biological opinion (NMFS 2020b), and biological opinions on hatchery operations within the DPS (NMFS 2007, 2008, 2017, 2018, 2019b).

The greatest opportunities to achieve population and MPG viability toward advancing DPS recovery are:

- Protect and enhance Columbia River habitat in identified coldwater refuge areas between Bonneville and McNary Dams (EPA 2021) for the protection of all populations from each MPG.
- **Cascade Eastern Slope Tributaries MPG:**
    - Continue to support and implement the Fifteenmile Action Plan for Stream Temperature (FAST) to improve streamflows and water temperatures (Fifteenmile Creek population).
    - Increase summer stream flow and decrease summer water temperatures (Fifteenmile Creek, Deschutes River Eastside and Deschutes River Westside populations).
- **Yakima MPG:**
    - Continue implementation of high priority actions in the Yakima Integrated Plan prioritizing spring flow and lower river facility improvements (all populations).
    - Restore complex floodplain habitats in mainstem reaches (Wapato, Gap to Gap-*in progress*, Lower Naches (Naches and Upper Yakima populations), as well as in Kittitas and Cle Elum reaches (Upper Yakima River population).
- **John Day MPG:**
    - Advance water conservation agreements with agricultural and domestic water users and continue to work with partners to implement high priority, tributary habitat restoration and protection actions (all populations).
    - Continue to improve passage and screening in the Lower Mainstem- and Upper Mainstem John Day River population areas.
- **Walla Walla/Umatilla MPG:**
    - Continue flow and passage improvements in the Umatilla (Bureau of

Reclamation), Walla Walla and Touchet Rivers, especially at Bennington Dam, the Mill Creek channel, and at Nursery Bridge.

- Provide passage: (1) and evaluate reintroduction feasibility over McKay Dam, a high priority passage action identified by the State of Oregon (Umatilla population); and (2) up Mill Creek, a tributary to the Walla Walla River to achieve abundance, productivity, and spatial structure goals for summer-run steelhead (Walla Walla population).
- Address Bureau of Reclamation flow management issues in the lower Umatilla River (Umatilla population).

5. References

5.1 Federal Register Notices

November 20, 1991. (56 FR 58612). Notice of Policy: Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon.

February 7, 1996. (61 FR 4722). Notice of Policy: Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act.

March 25, 1999. (64 FR 14517). Endangered and threatened species: threatened status for two ESUs of chum salmon in Washington and Oregon, for two ESUs of steelhead in Washington and Oregon and for Ozette Lake sockeye salmon in Washington. Federal Register 64(57):14508-14517, 3/25/1999.

September 16, 1999. (64 FR 50394). Endangered and Threatened Species; Threatened Status for Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California.

July 10, 2000. (65 FR 42422). Endangered and Threatened Species: Final Rule Governing Take of 14 Threatened Salmon and Steelhead Evolutionarily Significant Units (ESUs). Federal Register 65 (132): 42422-42481, 7/10/2000.

June 28, 2005. (70 FR 37159). Final Rule: Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs.

June 28, 2005. (70 FR 37204). Final Policy: Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead.

September 2, 2005. (70 FR 52630). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead in Washington, Oregon, and Idaho.

January 5, 2006. (71 FR 834). Final Rule: Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead.

September 30, 2009. (74 FR 50165). Middle Columbia River steelhead Distinct Population Segment ESA Recovery Plan. National Marine Fisheries, Portland, Oregon, 9/30/2009.

August 15, 2011. (76 FR 50448). Notice of availability of 5-year reviews: Endangered and Threatened Species; 5-Year Reviews for 17 Evolutionarily Significant Units and Distinct Population Segments of Pacific Salmon and Steelhead.

April 14, 2014. (79 FR 20802). Final Rule: Endangered and Threatened Wildlife; Final Rule to Revise the Code of Federal Regulations for Species Under the Jurisdiction of the National Marine Fisheries Service.

May 26, 2016. (81 FR 33468). Notice of Availability of 5-year Reviews Endangered and Threatened Species; 5-Year Reviews for 28 Listed Species of Pacific Salmon, Steelhead, and Eulachon.

April 30, 2019. (84 FR 18243). Notice of Final Guidelines: Endangered and Threatened Species; Listing and Recovery Priority Guidelines.

October 4, 2019. (84 FR 53117). Notice of Initiation of 5-year Reviews: Endangered and Threatened Species; Initiation of 5-Year Reviews for 28 Listed Species of Pacific Salmon and Steelhead.

December 17, 2020. (85 FR 81822). Final Rule: Revisions to Hatchery Programs Included as Part of Pacific Salmon and Steelhead Species Listed Under the Endangered Species Act.

January 13, 2021. (86 FR 2744). Final rule. Army Corps of Engineers. Reissuance and Modification of Nationwide Permits (12 permits).

December 27, 2021. (86 FR 73522). Final rule. Army Corps of Engineers. Reissuance and Modification of Nationwide Permits (41 permits).

5.2 Literature Cited

Anttila, K., A. P. Farrell, D. A. Patterson, S. G. Hinch, and E. J. Eliason. 2019. Cardiac SERCA activity in sockeye salmon populations: an adaptive response to migration conditions. Canadian Journal of Fisheries and Aquatic Sciences 76(1):1-5.

Bare, C. M., and coauthors. 2017. Escapement and Productivity of Steelhead and Spring Chinook Salmon in the John Day River, 2016 Annual Report, Bonneville Power Administration Project 1998-016-00.

Bare, C. M., and coauthors. 2019. Escapement and Productivity of Steelhead and Spring Chinook Salmon in the John Day River, 2018 Annual Report, Bonneville Power Administration Project 1998-016-00, Document ID #P163749.

Beckman, B. 2020. Communication to L. Krasnow (NMFS) from B. Beckman (NMFS), 5/20/2020.

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, G. Pess, et al. 2013. Restoring salmon habitat for a changing climate. River Research and Application 29:939-960.

Bottom, D. L., C. A. Simenstad, J. Burke, A. M. Baptista, D. A. Jay, K. K. Jones, et al. 2005. Salmon at river's end: The role of the estuary in the decline and recovery of Columbia River salmon. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-68, 8/1/2005.

BPA (Bonneville Power Administration), USBR (U.S. Bureau of Reclamation), and USACE (U.S. Army Corps of Engineers). 2020. Biological Assessment of Effects of the Operations and Maintenance of the Federal Columbia River System on ESA-Listed Species. Bonneville Power Administration, Portland, Oregon, 1/1/2020.

Brodeur, R. D., T. D. Auth, and A. J. Phillips. 2019. Major shifts in pelagic micronekton and macrozooplankton community structure in an upwelling ecosystem related to an unprecedented marine heatwave. Frontiers in Marine Science 6:212.

Brophy, L. S., C. M. Greene, V. C. Hare, B. Holycross, A. Lanier, W. N. Heady, et al. 2019. Insights into estuary habitat loss in the western United States using a new method for mapping maximum extent of tidal wetlands. PLoS ONE 14(8): e0218558.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-27, 261 p.

Carmichael, R. W. and B. J. Taylor. 2010. Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment, (Appendix A of NMFS 2009), 2/1/2010.

Carmichael, R. W., J. R. Ruzycki, and I. A. Tattam. 2012. Chinook Salmon Productivity and Escapement Monitoring in the John Day River Basin Annual Technical Report. July 1, 2011–June 30, 2012.

Carpenter, A. L., C. M. Barr, E. Tinus, and P. Chambliss. 2018. System-wide predator control program: Fisheries and biological evaluation. Pages 47-117 in Williams, S., E. Winther, C. M. Barr, and C. Miller. 2018. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River Basin northern pikeminnow sport reward program, 2017 Annual Report for BPA Project No. 1990-077-00.

Carretta, J. V., K. A. Forney, E. M. Oleson, D. W. Weller, A. R. Lang, J. Baker, et al. 2019. U.S. Pacific marine mammal stock assessments: 2018. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-617, 6/1/2019.

Carr-Harris, C. N., J. W Moore, A. S. Gottesfeld, J. A. Gordon, W. M. Shepert, J. D. J. Henry Jr., H. J. Russell, W. N. B. Helin, D. J. Doolan, and T. D. Beacham. 2018. Phenological diversity of salmon smolt migration timing within a large watershed. Transactions of the American Fisheries Society 147(5):775-790.

Climate Impacts Group. 2004. Overview of climate change impacts in the U.S. Pacific Northwest. University of Washington, Seattle, Washington, 7/29/2004.

Conley, A. (Yakima Basin Fish and Wildlife Recovery Board). 2020. Response to D. Driscoll, NOAA Fisheries, regarding a request for information pertaining to the 2021 MCR steelhead 5-year Status Review.

Conley, W. 2015. Fluvial Reconnaissance of Rock Creek and Selected Tributaries with Implications for Anadromous Salmonid Habitat Management. Prepared for Bonneville Power Administration. Project no. 2007-156-00 Yakama Nation Fisheries Program, 12/12/2015.

Cramer, B., K. Collis, A. F. Evans, D. D. Roby, D. E. Lyons, T. J. Lawes, Q. Payton, and A. Turecek. 2021. Chapter 6: Predation on juvenile salmonids by colonial waterbirds nesting at unmanaged colonies in the Columbia River basin in D. D. Roby, A. F. Evans, and K. Collis (editors). Avian Predation on Salmonids in the Columbia River Basin: A Synopsis of Ecology and Management. A synthesis report submitted to the U.S Army Corps of Engineers, Walla Walla, Washington; the Bonneville Power Administration, Portland, Oregon; the Grant County Public Utility District/Priest Rapids Coordinating Committee, Ephrata, Washington; and the Oregon Department of Fish and Wildlife, Salem, Oregon. 788 pp.

Crozier, L. 2016. Impacts of Climate Change on Salmon of the Pacific Northwest: A Review of the Scientific Literature Published in 2015. Northwest Fisheries Science Center. October 2016.

Crozier, L. G. and R. W. Zabel. 2006. Climate impacts at multiple scales: evidence for differential population responses in juvenile Chinook salmon. Journal of Animal Ecology. 75:1100-1109.

Crozier, L. G., B. J. Burke, B. E. Chasco, D. L. Widener, and R. W. Zabel. 2021. Climate change threatens Chinook salmon throughout their life cycle. Commun Biol 4, 222 (2021). https://doi.org/10.1038/s42003-021-01734-w

Crozier, L. G., M. M. McClure, T. Beechie, S. J. Bograd, D. A. Boughton, M. Carr, T. D. Cooney, et al. 2019. Climate vulnerability assessment for Pacific salmon and steelhead in the California Current Large Marine Ecosystem. PLoS ONE 14(7): e0217711. https://doi.org/10.1371/journal.pone.0217711

Crozier, L. G., R. W. Zabel, and A. F. Hamlet. 2008. Predicting differential effects of climate change at the population level with life-cycle models of spring Chinook salmon. Global Change Biology 14:236-249.

DART (Columbia River Data Access in Real Time). 2020a. PIT Tag Adult Returns Conversion Rates Bonneville to The Dalles: Adult PIT-Tagged Wild Summer Steelhead Released in Deschutes and Observed at Bonneville, January-December (2013-2019). Last accessed 03 August 2020; http://www.cbr.washington.edu/dart/

DART (Columbia River Data Access in Real Time). 2020b. PIT Tag Adult Returns Conversion Rates Bonneville to The Dalles: Adult PIT-Tagged Wild Summer Steelhead Released in John Day and Observed at Bonneville, January-December (2013-2019). Last accessed 03 August 2020; http://www.cbr.washington.edu/dart/

DART (Columbia River Data Access in Real Time). 2020c. PIT Tag Adult Returns Conversion Rates Bonneville to The Dalles: Adult PIT-Tagged Wild Summer Steelhead Released in Umatilla and Observed at Bonneville, January-December (2013-2019). Last accessed 03 August 2020; http://www.cbr.washington.edu/dart/

DART (Columbia River Data Access in Real Time). 2020d. PIT Tag Adult Returns Conversion Rates Bonneville to The Dalles: Adult PIT-Tagged Wild Summer Steelhead Released in Walla Walla and Observed at Bonneville, January-December (2013-2019).

Deschutes River Conservancy and Deschutes Water Alliance (DRC and DWA). 2013. Deschutes Water Planning Initiative: water supply goals and objectives. Final Report.

Dunlap, P. V., R. M. Shirley, J. D. Hone, and E. C. Winther. 2018. Northern pikeminnow dam angling on the Columbia River, 2017 Annual Report. Pages 118-148 in Williams, S., E. Winther, C. M. Barr, and C. Miller. 2018. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River Basin northern pikeminnow sport reward program, 2017 Annual Report for BPA Project No. 1990-077-00.

EPA (U.S. Environmental Protection Agency). 2021. Columbia River cold water refuges plan. EPA-910-R-21-001. U.S. Environmental Protection Agency, Region 10.

Erhardt, J. M. and K. F. Tiffan. 2018 Post-release predation mortality of age-0 hatchery-reared Chinook salmon from non-native smallmouth bass in the Snake River. Fish Manag Ecol. 2018; 25: 474– 487. https://doi.org/10.1111/fme.12322

Erhardt, J. M., K. F. Tiffan, and W. P. Connor. 2018. Juvenile Chinook Salmon Mortality in a Snake River Reservoir: Smallmouth Bass Predation Revisited. Trans Am Fish Soc, 147: 316-328. https://doi.org/10.1002/tafs.10026

Espinasse, B., B. P. V. Hunt, Y. D. Coll, and E. A. Pakhomov. 2019. Investigating high seas foraging conditions for salmon in the North Pacific: insights from a 100-year scale archive for Rivers Inlet sockeye salmon. Canadian Journal of Fisheries and Aquatic Sciences 76(6):918-927.

Evans, A., Q. Payton, B. Cramer, K. Collis, J. Tennyson, P. Loschl, and D. Lyons. 2018. East Sand Island passive integrated transponder tag recovery and avian predation rate analysis, 2017. Final Technical Report. Submitted to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon. 2/152018.

Evans, A. F., Q. Payton, K. Collis, B. Cramer, A. Turecek, N. J. Hostetter, and D. D. Roby. 2021. Chapter 7: Cumulative effects of avian predation on juvenile salmonids in the Columbia River basin in D. D. Roby, A. F. Evans, and K. Collis (editors). Avian Predation on Salmonids in the Columbia River Basin: A Synopsis of Ecology and Management. A synthesis report submitted to the U.S Army Corps of Engineers, Walla Walla, Washington; the Bonneville Power Administration, Portland, Oregon; the Grant County Public Utility District/Priest Rapids Coordinating Committee, Ephrata, Washington; and the Oregon Department of Fish and Wildlife, Salem, Oregon. March 31, 2021.

Faber, D. W., K. J. Pierson, and J. R. Ruzycki. 2018. Abundance, Productivity, and Life History of Fifteenmile Creek Steelhead, 1/1/2017 - 12/31/2017. BPA Annual Technical Report, Project # 2010-035-00, Document ID #P159201.

Ford, M. J. 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-113.

Ford, M. J., editor. 2022. Biological viability assessment update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-171.

Friesen, T. A. and D. L. Ward. 1999. Management of northern pikeminnow and implications for juvenile salmonid survival in the lower Columbia and Snake rivers. North American Journal of Fisheries Management 19:406-420.

Fritts, A. L. and T. N. Pearsons. 2006. Effects of predation by nonnative smallmouth bass on native salmonid prey: the role of predator and prey size. Transactions of the American Fisheries Society 135:853-860.

Gliwicz, Z. M., E. Babkiewicz, R. Kumar, S. Kunjiappan, and K. Leniowski. 2018. Warming increases the number of apparent prey in reaction field volume of zooplanktivorous fish. Limnology and Oceanography 63:S30-S43.

Good, T. P., R. S. Waples, and P. Adams (Editors). 2005. Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-66, 598 p.

Gourtay, C., D. Chabot, C. Audet, H. Le Delliou, P. Quazuguel, G. Claireaux, and J. L. Zambonino-Infante. 2018. Will global warming affect the functional need for essential fatty acids in juvenile sea bass (Dicentrarchus labrax)? A first overview of the consequences of lower availability of nutritional fatty acids on growth performance. Marine Biology 165(9):165:143.

Hanson, J. T. 2018. Migration Patterns of PIT-Tagged Adult Umatilla River Natural Origin Steelhead in the Columbia River Basin. Presented at the Umatilla Management Monitoring & Evaluation Oversight Committee (UMMEOC) Meeting, December 2018, Pendleton, Oregon.

Hanson, J. T., S. M. Jewett, and S. Remple. 2017. Evaluation of Juvenile Salmonid Outmigration and Survival in the Lower Umatilla River Basin, 1/1/2016 - 12/31/2016. BPA Annual Technical Report, Project # 1989-024-01. {37 Electronic Pages}.

Hanson, J. T., S. M. Jewett, and S. Remple. 2020. Evaluation of Juvenile Salmonid Outmigration and Survival in the Lower Umatilla River Basin, 1/2019-12/2019. Technical Report to Bonneville Power Administration, Project # 1989-024-01, Document ID #P171666, 34 electronic pages.

Hardiman, J. M. and E. Harvey. 2019. Fish and habitat assessment in Rock Creek, Klickitat County, Washington 2016–17: U.S. Geological Survey Open-File Report 2019-1092, 67 p., https://doi.org/10.3133/ofr20191092.

Harper, J. and K. Collis. 2018. 2018 hazing and dissuasion of Caspian terns in the lower Columbia estuary: Season end summary report. Prepared for: U.S. Army Corps of Engineers – Portland District. 333 SW 1st Avenue, Portland, Oregon 97204. August 28, 2018.

Hatch, D., R. Branstetter, J. Stephenson, A. Pierce, J. Newell, W. Bosch, N. Graham, L. Medeiros, L. Jenkins, B. Hoffman, J. Vrtelova-Holbert, T. Cavileer, J. Nagler, C. Frederickson, J. Blodgett, D. Fast, M. Fiander, R. Lessard, J. Whiteaker, S. Everett, and R. Johnson. 2018. Kelt Reconditioning and Reproductive Success Evaluation Research. 1/1/2017 - 12/31/2017 Bonneville Power Administration Annual Report, 2007-401-00.

Hawkins, B. L., A. H. Fullerton, B. L. Sanderson, and E. A. Steel. 2020. Individual-based simulations suggest mixed impacts of warmer temperatures and a nonnative predator on Chinook salmon. Ecosphere 11(8):e03218. 10.1002/ecs2.3218

Herring, S. C., N. Christidis, A. Hoell, M. P. Hoerling, and P. A. Stott, eds. 2018. Explaining extreme events of 2016 from a climate perspective. Bulletin of the American Meteorological Society 99.

Hillman, T., M. Miller, C. Willard, et al. 2015. Monitoring and evaluation of the Chelan and Grant County PUDs Hatchery Programs. 2014 Annual Report. Prepared for: HCP Hatchery Committee and PRCC Hatchery Sub-Committee Wenatchee and Ephrata, WA. 748 p.

ICTRT (Interior Columbia Technical Recovery Team). 2003. Independent populations of Chinook, steelhead, and sockeye for listed evolutionarily significant units within the Interior Columbia River Domain. Northwest Fisheries Science Center.

ICTRT (Interior Columbia Technical Recovery Team). 2007a. Required Survival Rate Changes to meet Technical Recovery Team Abundance and Productivity Viability Criteria for Interior Columbia River Basin Salmon and Steelhead Populations.

ICTRT (Interior Columbia Technical Recovery Team). 2007b. Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. Interior Columbia Basin Technical Recovery Team Technical Review Draft. March 2007. 91 p. + Appendices and Attachments.

ICTRT (Interior Columbia Technical Recovery Team), and R. W. Zabel. 2007. Assessing the Impact of Environmental Conditions and Hydropower on Population Productivity for Interior Columbia River Stream-type Chinook and Steelhead Populations.

IPCC (Intergovernmental Panel on Climate Change). 2014. Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J. C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC (Intergovernmental Panel on Climate Change). 2018. Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

Isaak, D. J., C. H. Luce, D. L. Horan, G. L. Chandler, S. P. Wollrab, and D. E. Nagel. 2018. Global warming of salmon and trout rivers in the northwestern U.S.: Road to ruin or path through purgatory? Transactions of the American Fisheries Society 147:566-587.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River Basin fish and wildlife. In: Climate Change Report, ISAB 2007-2. Independent Scientific Advisory Board, Northwest Power and Conservation Council, Portland, Oregon, 5/11/2007.

ISAB (Independent Scientific Advisory Board). 2011. Columbia River food webs: Developing a broader scientific foundation for fish and wildlife Restoration. ISAB Report 2011-1, Portland, Oregon, 1/7/2011.

ISAB (Independent Scientific Advisory Board). 2015. Density dependence and its implications for fish management and restoration programs in the Columbia River basin. ISAB Report 2015-1, Portland, Oregon, 2/25/2015.

Islam, S. U., R. W. Hay, S. J. Dery, and B. P. Booth. 2019. Modelling the impacts of climate change on riverine thermal regimes in western Canada's largest Pacific watershed. Scientific Reports 9:14.

Jacox, M. G., M. A. Alexander, C. A. Stock, and G. Hervieux. 2019. On the skill of seasonal sea surface temperature forecasts in the California Current System and its connection to ENSO variability. Climate Dynamics 53(12):7519-7533.

John Day Basin Partnership. 2018. John Day Basin Partnership strategic action plan. Version 4.0.

Johnson, G. E., K. L. Fresh, and N. K. Sather, eds. 2018. Columbia estuary ecosystem restoration program: 2018 Synthesis memorandum. Final Report. submitted by Pacific Northwest National Laboratory to U.S. Army Corps of Engineers, Portland District, Portland, Oregon, 6/1/2018.

Karnezis, J. 2019. FW: [EXTERNAL] Re: FW: [Non-DoD Source] Re: checking with you re. edits to env baseline Communication to L. Krasnow (NMFS) from J. Karnezis (BPA), 12/19/2019.

Keefer, M., and coauthors. 2016. Adult Steelhead Passage Behaviors and Survival in the Federal Columbia River Power System. Final Technical Report (IDIQ Contract No. W912EF-14-D-0004) prepared for U.S. Army Corps of Engineers, Walla Walla District. University of Idaho, Moscow, Idaho.

Krosby, M., D. M. Theobald, R. Norheim, and B. H. McRae. 2018. Identifying riparian climate corridors to inform climate adaptation planning. Plos One 13(11):e0205156.

Kukulka, T. and D. A. Jay. 2003. Impacts of Columbia River discharge on salmonid habitat: 2. Changes in shallow-water habitat. Journal of Geophysical Research 108(C9): 3294. DOI: 10.1029/2003JC001829.

Lawes, T. J., K. S. Bixler, D. D. Roby, D. E. Lyons, K. Collis, A. F. Evans, A. Peck-Richardson, B. Cramer, Y. Suzuki, J. Y. Adkins, K. Courtot, and Q. Payton. 2021. Chapter 4: Double-crested cormorant management in the Columbia River estuary in D. D. Roby, A. F. Evans, and K. Collis (editors). Avian Predation on Salmonids in the Columbia River Basin: A Synopsis of Ecology and Management. A synthesis report submitted to the U.S. Army Corps of Engineers, Walla Walla, Washington; the Bonneville Power Administration, Portland, Oregon; the Grant County Public Utility District/Priest Rapids Coordinating Committee, Ephrata, Washington; and the Oregon Department of Fish and Wildlife, Salem, Oregon. 788 pp.

Lawrence, D. J., J. D. Olden, and C. E. Torgersen. 2012. Spatiotemporal patterns and habitat associations of smallmouth bass (Micropterus dolomieu) invading salmon-rearing habitat. Freshwater Biology, 57: 1929-1946. https://doi.org/10.1111/j.1365-2427.2012.02847.x

Leach, J. A. and R. D. Moore. 2019. Empirical Stream Thermal Sensitivities May Underestimate Stream Temperature Response to Climate Warming. Water Resources Research 55(7):5453-5467.

Lindsey, R. and L. Dahlman. 2020. Climate change: Global temperature. https://www.climate.gov/news-features/understanding-climate/climate-change-globaltemperature. Accessed 1/16/2020.

Lynch, A. J., B. J. E. Myers, C. Chu, L. A. Eby, J. A. Falke, R. P. Kovach, T. J. Krabbenhoft, et al. 2016. Climate change effects on North American inland fish populations and assemblages. Fisheries 41(7): 346-361.

Macfarlane, W. W., and coauthors. 2017. Riparian vegetation as an indicator of riparian condition: Detecting departures from historic condition across the North American West. Journal of Environmental Management 202:447-460.

Macfarlane, W. W., and coauthors. 2018. What are the Conditions of Riparian Ecosystems? Identifying Impaired Floodplain Ecosystems across the Western U.S. Using the Riparian Condition Assessment (RCA) Tool. Environmental Management 62(3):548-570.

Macfarlane, W. W., and coauthors. 2019. John Day Basin Beaver Restoration Assessment Tool: building realistic expectations for partnering with beaver in restoration and conservation. Prepared for the North Fork John Day Watershed Council. Utah State University, Logan, Utah.

Maier, G. O. and C. A. Simenstad. 2009. The role of marsh-derived macrodetritus to the food webs of juvenile Chinook salmon in a large altered estuary. Estuaries and Coasts 32:984-998. DOI: 10.1007/s12237-009-9197-1.

Marcoe, K. and S. Pilson. 2017. Habitat change in the lower Columbia River estuary, 1870-2009. Journal of Coastal Conservation 21:505-525. DOI: 10.1007/s11852-017-0523-7.

Martins, E. G., S. G. Hinch, D. A. Patterson, M. J. Hague, S. J. Cooke, K. M. Miller, et al. 2011. Effects of river temperature and climate warming on stock-specific survival of adult migrating Fraser River sockeye salmon (Oncorhynchus nerka). Global Change Biology 17(1):99–114.

Martins, E. G., S. G. Hinch, D. A. Patterson, M. J. Hague, S. J. Cooke, and K. M. Miller. 2012. High river temperature reduces survival of sockeye salmon (Oncorhynchus nerka) approaching spawning grounds and exacerbates female mortality. Canadian Journal of Fisheries and Aquatic 69:330–342.

McClure, M., T. Cooney and the ICTRT (Interior Columbia Technical Recovery Team). 2005. Memorandum To: NMFS NW Regional Office, Co-managers and Other Interested Parties re: Updated Population Delineation in the Interior Columbia Basin.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. NOAA Technical Memorandum NMFS-NWFSC–42, NOAA Technical Memorandum NMFS-NWFSC-42.

McHugh, P. A., and coauthors. 2017. Linking models across scales to assess the viability and restoration potential of a threatened population of steelhead (Oncorhynchus mykiss) in the Middle Fork John Day River, Oregon, USA. Ecological Modelling 355:24-38.

McMichael, G. A. 2018. Upriver bright predator abundance estimation. Final Report to the Letter of Agreement- U. S. Chinook Technical Committee, Pacific Salmon Commission, under contract CTC-2017-1.

Macnab, B. A. and S. L. Springston. 2019. Fifteenmile Creek Habitat Restoration Project, 3/01/18 through 1/31/19. BPA Annual Project Report, Project # 1993-040-00, Document ID #P167719

Mid-C Forum Steering Committee (2018). Middle Columbia River Steelhead DPS 2016 Population Data Set Summary: MPG-Specific Recovery Action Prioritization.

Middle Fork Intensively Monitored Watershed Working Group (MFIMW WG). 2017. Middle Fork John Day River Intensively Monitored Watershed Final Summary Report.

Morgan, C. A., B. R. Beckman, L. A. Weitkamp, and K. L. Fresh. 2019. Recent ecosystem disturbance in the northern California Current. American Fisheries Society 44(10): 465-474.

Mote, P. W., E. A. Parson, A. F. Hamlet, W. S. Keeton, D. Lettenmaier, N. Mantua, et al. 2003. Preparing for climatic change: The water, salmon, and forests of the Pacific Northwest. Climatic Change 61:45-88.

Murdoch, A., M. Schuck, J. D. Bumgarner, and G. Mendel. 2012. Downstream migration and fate of wandering steelhead. WDFW (Washington Department of Fish and Wildlife) Science Issue Paper. Fish Program-Science Division, Hatchery/Wild Interactions Unit, Wenatchee, Washington.

Naiman, R. J., J. Richard Alldredge, D. A. Beauchamp, P. A. Bisson, J. Congleton, C. J. Henny, N. Huntly, R. Lamberson, C. Levings, E. N. Merrill, W. G. Pearcy, B. E. Rieman, G. T. Ruggerone, D. Scarnecchia, P. E. Smouse, and C. C. Wood. 2012. River restoration and food webs. Proceedings of the National Academy of Sciences Dec 2012, 109 (52) 21201-21207; DOI: 10.1073/pnas.1213408109

Nelson, T. 2019. Trout Creek Habitat Restoration Project, 1/1/2018 - 12/31/18. BPA Annual Project Report, Project # 1994-042-00, Document ID #P168292, 39 electronic pages.

NMFS (National Marine Fisheries Service). 1997. Status Review Update for West Coast Steelhead from Washington, Idaho, Oregon, and California. July 7, 1997, NMFS-NWFSC/SWFSC Status Review Update Memo.

NMFS (National Marine Fisheries Service). 1999a. Updated Review of the Status of Upper Willamette River and Middle Columbia River ESUs of Steelhead. January 12, 1999. NMFS-NWFSC Status Review Update Memo.

NMFS (National Marine Fisheries Service). 1999b. Evaluations of the Status of Chinook and Chum Salmon and Steelhead Hatchery Populations for ESUs Identified in Final Listing Determinations. March 4, 1999. NMFS-NWFSC Status Review Update Memo.

NMFS (National Marine Fisheries Service). 2007. Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan. August 1, 2007. 1271pp

NMFS (National Marine Fisheries Service). 2008. Endangered Species Act - Section 7 Consultation Biological Opinion. Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin, and ESA Section 10(a)(I)(A) Permit for Juvenile Fish Transportation Program. NMFS, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2009. Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan. NMFS Northwest Region, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2010. National Marine Fisheries Service Endangered Species Act Section 7 Consultation, Biological Opinion: Environmental Protection Agency Registration of Pesticides Containing Azinphos methyl, Bensulide, Dimethoate, Disulfoton, Ethoprop, Fenamiphos, Naled, Methamidophos, Methidathion, Methyl parathion, Phorate and Phosmet.

NMFS (National Marine Fisheries Service). 2013. Endangered and Threatened Species: Designation of a Nonessential Experimental Population for Middle Columbia River Steelhead Above the Pelton Round Butte Hydroelectric Project in the Deschutes River Basin, OR. Federal Register 78 (10): 2893- 2907, 1/15/2013.

NMFS (National Marine Fisheries Service). 2014. Endangered Species Act Section 7(a)(2) Supplemental Biological Opinion – Consultation on Remand for Operation of the Federal Columbia River Power System, Northwest Region.

NMFS (National Marine Fisheries Service). 2015. Endangered Species Act Biological Opinion on the Environmental Protection Agency's Proposed Approval of Certain Oregon Water Quality Standards Including Temperature and Intergravel Dissolved Oxygen. WCR 2013-76.

NMFS (National Marine Fisheries Service). 2016a. 5-year review: Summary and Evaluation of Middle Columbia River Steelhead. NMFS West Coast Region, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2016b. 2015 Adult Sockeye Salmon Passage Report. September 2016.

NMFS (National Marine Fisheries Service). 2017. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. NOAA's National Marine Fisheries Service's implementation of the Mitchell Act Final Environmental Impact Statement preferred alternative and administration of Mitchell Act hatchery funding. January 15, 2017. NMFS Consultation No.: WCR-2014-697. 535p.

NMFS (National Marine Fisheries Service). 2018. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response. Consultation on effects of the 2018-2027 U.S. v. Oregon Management Agreement. February 23, 2018. NMFS Consultation No.: WCR-2017-7164.

NMFS (National Marine Fisheries Service). 2019a. Recovering Threatened and Endangered Species, FY 2017-2018 Report to Congress. National Marine Fisheries Service. Silver Spring, MD.

NMFS (National Marine Fisheries Service). 2019b. Endangered Species Act Section 7(a)(2) biological opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat consultation for the continued operation and maintenance of the Columbia River System. NMFS Consultation Number: WCRO-2018-00152. National Marine Fisheries Service, West Coast Region, 3/29/2019.

NMFS (National Marine Fisheries Service). 2019c. Mid-Columbia River Steelhead and Spring Chinook Salmon Hatchery Programs Reinitiation 2018. NMFS Consultation Number: WCRO-2018-01252. National Marine Fisheries Service, West Coast Region, 4/23/2019.

NMFS (National Marine Fisheries Service). 2020a. Recovery Planning Handbook. Version 1.0. U.S. Department of Commerce, NOAA National Marine Fisheries Service. October 29, 2020.

NMFS (National Marine Fisheries Service). 2020b. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Continued Operation and Maintenance of the Columbia River System. July 24, 2020. NMFS Consultation Number: WCRO 2020-00113.

NMFS (National Marine Fisheries Service). 2022. Recovering Threatened and Endangered Species, FY 2019–2020 Report to Congress. National Marine Fisheries Service. Silver Spring, MD. Report available online at: https://www.fisheries.noaa.gov/resource/document/recovering-threatened-and-endangered-species-report-congress-fy-2019-2020.

NWFSC (Northwest Fisheries Science Center). 2015. Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest. December 21, 2015.

OCCRI (Oregon Climate Change Research Institute). 2019. Fourth Oregon climate assessment report. P. W. Mote, J. Abatzoglou, K. D. Dello, K. Hegewisch and D. E. Rupp, editors. Oregon State University, Corvallis, Oregon. https://oregonstate.app.box.com/s/vcb1tdkxvisghzsom445l5wpu256ecqf

OCCRI (Oregon Climate Change Research Institute). 2021. Fifth Oregon climate assessment. M.M. Dalton and E. Fleishman, editors. Oregon State University, Corvallis, Oregon. https://oregonstate.app.box.com/s/7mynjzhda9vunbzqib6mn1dcpd6q5jka

ODFW (Oregon Department of Fish and Wildlife). 2010. Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment.

ODFW (Oregon Department of Fish and Wildlife). 2012. Oregon Middle Columbia Summer Steelhead Conservation and Recovery Plan Implementation Toolkit: guidance document and population summary spreadsheets. Available at: http://www.dfw.state.or.us/fish/CRP/mid_columbia_river_plan.asp

ODFW (Oregon Department of Fish and Wildlife). 2017. A. W. Averett and J. R. Ruzycki, personal communication, July 27, 2017 and July 28, 2017.

ODFW (Oregon Department of Fish and Wildlife). 2019a. 2019 Statewide Fish Passage Priority List. Prepared by A.W. Averett. Oregon Department of Fish and Wildlife, Fish Passage and Screening Program, Salem, Oregon. https://www.dfw.state.or.us/fish/passage/

ODFW (Oregon Department of Fish and Wildlife). 2019b. Oregon Middle Columbia Steelhead Conservation and Recovery Plan Implementation Report for 2010 – 2016. Prepared by A.W. Averett. Oregon Department of Fish and Wildlife, East Region, La Grande, Oregon. https://www.dfw.state.or.us/fish/CRP/docs/mid_columbia_river/MCRStCRPlanReport_2010-2016_final_20190923.pdf

ODFW (Oregon Department of Fish and Wildlife). 2020. Commission adopts 2021 Sport Fishing Regulations, including rules regarding Columbia River thermal angling sanctuaries. https://www.dfw.state.or.us/news/2020/08_Aug/080720b.asp. Accessed 9/16/2021.

Pess, G. and C. E. Jordan, eds. 2019. Characterizing watershed-scale effects of habitat restoration actions to inform life cycle models: Case studies using ata-rich vs. data-poor approaches. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-151.

PFMC (Pacific Fishery Management Council). 2020. Review of 2019 Ocean Salmon Fisheries: Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan. PFMC, Portland, OR. 337 p.

Pierson, D. J., D. W. Faber, and J. R. Ruzycki. 2017. Abundance, Productivity, and Life History of Fifteenmile Creek Steelhead, 1/1/2016 - 12/31/2016. BPA Annual Technical Report, Project # 2010-035-00.

PNNL (Pacific Northwest National Laboratory) and NMFS (National Marine Fisheries Service). 2018. Restoration Action Effectiveness Monitoring and Research in the Lower Columbia River and Estuary, 2016-2017. Progress report prepared for the U.S. Army Corps of Engineers, Portland District, Portland, Oregon, 9/14/2018.

PNNL (Pacific Northwest National Laboratory) and NMFS (National Marine Fisheries Service). 2020. Restoration Action Effectiveness Monitoring and Research in the Lower Columbia River and Estuary, 2016-2017. Final technical report submitted by PNNL and NMFS to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon. 6/1/2020

Rehage, J. S. and J. R. Blanchard. 2016. What can we expect from climate change for species invasions? Fisheries 41(7): 405-407.

Richins, S. M. 2017. Influence of juvenile and adult experiences on tributary overshoot and fallback by steelhead in the Columbia River basin. M.S. Thesis, University of Washington. 322 pp.

Richins, S. M. and J. R. Skalski. 2018. Steelhead Overshoot and Fallback Rates in the Columbia–Snake River Basin and the Influence of Hatchery and Hydrosystem Operations. North American Journal of Fisheries Management 38.

Roby, D. D., K. Collis, P. J. Loschl, Y. Suzuki, D. Lyons, T. J. Lawes, et al. 2017. Avian predation on juvenile salmonids: Evaluation of the Caspian Tern Management Plan in the Columbia River estuary, 2016 Final annual report. U.S. Geological Survey, Oregon State University, Corvallis, Oregon, 3/21/2017.

Roby, D. D., T. J. Lawes, D. E. Lyons, K. Collis, A. F. Evans, K. S. Bixler, S. Collar, O. A. Bailey, Y. Suzuki, Q. Payton, and P. J. Loschl. 2021. Chapter 1: Caspian tern management in the Columbia River estuary in D. D. Roby, A. F. Evans, and K. Collis (editors). Avian Predation on Salmonids in the Columbia River Basin: A Synopsis of Ecology and Management. A synthesis report submitted to the U.S Army Corps of Engineers, Walla Walla, Washington; the Bonneville Power Administration, Portland, Oregon; the Grant County Public Utility District/Priest Rapids Coordinating Committee, Ephrata, Washington; and the Oregon Department of Fish and Wildlife, Salem, Oregon. 788 pp.

Rub, A. M. Wargo, N. A. Som, M. J. Henderson, B. P. Sandford, D. M. Van Doornik, D. J. Teel, M. J. Tennis, O. P. Langness, B. K. van der Leeuw, and D. D. Huff. 2019. Changes in adult Chinook salmon (Oncorhynchus tshawytscha) survival within the lower Columbia River amid increasing pinniped abundance. Canadian Journal of Fisheries and Aquatic Sciences 76 (10), 1862-1873, 10.1139/cjfas-2018-0290.

Rubenson, E. and Olden, J. D. 2016. Spatiotemporal Spawning Patterns of Smallmouth Bass at Its Upstream Invasion Edge. Transactions of the American Fisheries Society, 145: 693-702. https://doi.org/10.1080/00028487.2016.1150880

Rubenson, E. S., D. L. Lawrence, and J. D. Olden. 2020. Threats to Rearing Juvenile Chinook Salmon from Nonnative Smallmouth Bass Inferred from Stable Isotope and Fatty Acid Biomarkers. Trans Am Fish Soc, 149: 350-363. https://doi.org/10.1002/tafs.10237

Ruzycki, J. R. and J. Hanson. 2014. Migration and survival of adult Umatilla River steelhead. Presented at the Middle Columbia Wild Adult Steelhead Tributary Bypass Workshop, November 19, 2014, Walla Walla, Washington.

Ruzycki, J. R. and I. A. Tattam. 2014. Migration and survival of adult John Day River steelhead. Presented at the Middle Columbia Wild Adult Steelhead Tributary Bypass Workshop, November 19, 2014, Walla Walla, Washington.

Ruzycki, J. R., D. M. Faber, I. A. Tattam, B. Allen, and J. D. Bumgarner. 2015. Adult tributary overshoot behavior and fate within the FCRPS. Preliminary research proposal submitted to the Middle Columbia River Steelhead Recovery Steering Committee.

Sanderson, B. L., K. A. Barnas, and A. M. Wargo-Rub. 2009. Nonindigenous Species of the Pacific Northwest: An Overlooked Risk to Endangered Salmon? BioScience, Volume 59, Issue 3, March 2009, Pages 245–256, https://doi.org/10.1525/bio.2009.59.3.9

Scheuerell, M. D. and J. G. WIlliams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha). Fisheries Oceanography 14(6): 448–457.

Schtickzelle, N. and T. P. Quinn. 2007. A metapopulation perspective for salmon and other anadromous fish. 8(4):297-314.

Siegel, J. and L. Crozier. 2019. Impacts of Climate Change on Salmon of the Pacific Northwest: A review of the scientific literature published in 2018. Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA. December.

Siegel, J. and L. Crozier. 2020. Impacts of Climate Change on Salmon of the Pacific Northwest: A Review of the Scientific Literature Published in 2019. Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA.

Silverman, N. L., and coauthors. 2019. Low-tech riparian and wet meadow restoration increases vegetation productivity and resilience across semiarid rangelands. 27(2):269-278.

Simenstad, C. A., L. F. Small, and C. D. McIntyre. 1990. Consumption processes and food web structure in the Columbia River estuary. Progress in Oceanography 25:271-298.

Smith, D. L., S. P. Miner, C.H. Theiling, R. Behm, and J. M. Nestler. 2017. Levee setbacks: an innovative, cost-effective, and sustainable solution for improved flood risk management. ERDC/EL SR-17-3. U.S. Army Engineer Research and Development Center.

Sridhar, V., M. M. Billah, and J. W. Hildreth. 2018. Coupled surface and groundwater hydrological modeling in a changing climate. Groundwater 56(4):618-635.

Sykes, G. E., C. J. Johnson, and J. M. Shrimpton. 2009. Temperature and flow effects on migration timing of Chinook salmon smolts. Transactions of the American Fisheries Society 138:1252-1265.

TAC (U.S. v. Oregon Technical Advisory Committee). 2015. TAC Annual Report. Abundance, Stock Status and ESA Impacts. 2014 Summary. May 13-14, 2015.

TAC (U.S. v. Oregon Technical Advisory Committee). 2016. TAC Annual Report. Abundance, Stock Status and ESA Impacts. Summary of 2015 fisheries and fish runs. May 20, 2016.

TAC (U.S. v. Oregon Technical Advisory Committee). 2017. TAC Annual Report. Abundance, Stock Status and ESA Impacts. Summary of 2016 fisheries and fish runs. October 13, 2017.

TAC (U.S. v. Oregon Technical Advisory Committee). 2018. TAC Annual Report. Abundance, Stock Status and ESA Impacts. Summary of 2017 fisheries and fish runs. May 10-11, 2018.

TAC (U.S. v. Oregon Technical Advisory Committee). 2019. Technical Advisory Committee Annual Report: Abundance, Stock Status, Harvest, and Endangered Species Act Impacts. Summary of 2018 Fisheries and Fish Runs. May 9-10, 2019.

TAC (U.S. v. Oregon Technical Advisory Committee). 2020. Technical Advisory Committee Annual Report: Abundance, Stock Status, Harvest, and Endangered Species Act Impacts. Summary of 2019 Fisheries and Fish Runs. May 14-15, 2020.

Tidwell, K. S., B. K. van der Leeuw, L. N. Magill, B. A. Carrothers, and R. H. Wertheimer. 2018. Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam tailrace, 2017. U.S. Army Corps of Engineers, Portland District Fisheries Field Unit. Cascade Locks, Oregon, 3/5/2018.

Tidwell, K. S., D. A. McCanna, R. I. Cates, C. B. Ford and B. K. van der Leeuw. 2020. Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam tailrace, 2019. U.S. Army Corps of Engineers, Portland District, Fisheries Field Unit. Cascade Locks, Oregon.

Tiffan, K. F., J. R. Hatten, and D. A. Trachtenbarg. 2016. Assessing Juvenile Salmon Rearing Habitat and Associated Predation Risk in a Lower Snake River Reservoir. River Res. Applic., 32: 1030– 1038. doi: 10.1002/rra.2934.

Tiffan, K. F., J. M. Erhardt, R. J. Hemingway, et al. 2020. Impact of smallmouth bass predation on subyearling fall Chinook salmon over a broad river continuum. Environ Biol Fish 103, 1231–1246 (2020). https://doi.org/10.1007/s10641-020-01016-0

Trammell, J., D. E. Fast, D. R. Hatch, W. J. Bosch, R. Branstetter, A. L. Pierce, J. W. Blodgett, and C. R. Frederiksen. 2016. Evaluating Steelhead Kelt Treatments to Increase Iteroparous Spawners in the Yakima River Basin, North American Journal of Fisheries Management, 36:4, 876-887, DOI: 10.1080/02755947.2016.1165767

USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 2006. 5-Year Review Guidance: Procedures for Conducting 5-Year Reviews Under the Endangered Species Act. July 2006.

Veilleux, H. D., J. M. Donelson, and P. L. Munday. 2018. Reproductive gene expression in a coral reef fish exposed to increasing temperature across generations. Conservation Physiology 6:12.

Wainwright, T. C. and L. A. Weitkamp. 2013. Effects of Climate Change on Oregon Coast Coho Salmon: Habitat and Life-Cycle Interactions. Northwest Science. 87:219-242.

Wade, A. A., T. J. Beechie, E. Fleishman, N. J. Mantua, H. Wu, J. S. Kimball, D. M. Stoms, and J. A. Stanford. 2013. Steelhead vulnerability to climate change in the Pacific Northwest. Journal of Applied Ecology. 50:1093-1104.

Wathen, G., and coauthors. 2018. Beaver activity increases habitat complexity and spatial partitioning by steelhead trout. Canadian Journal of Fisheries and Aquatic Sciences 76(7):1086-1095.

WDFW (Washington Department of Fish and Wildlife). 2019. WDFW comments to EPA on the Lower Columbia Cold Water Refuge Plan.

Weber, N., and coauthors. 2017. Alteration of stream temperature by natural and artificial beaver dams. PLoS ONE 12(5):e0176313.

Whitney, J. E., R. Al-Chokhachy, D. B. Bunnell, C. A. Caldwell, S. J. Cooke, E. J. Eliason et al. 2016. Physiological basis of climate change impacts on North American inland fishes. Fisheries 41(7): 332-345.

Williams, S., E. Winther, and A. Storch. 2015. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River basin Northern Pikeminnow Sport Reward Program. 2015 Annual Report, April 1, 2015 through March 31, 2016. Pacific States Marine Fisheries Commission, Portland, Oregon.

Williams, S., E. Winther, and C. M. Barr. 2016. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River basin Northern Pikeminnow Sport Reward Program. 2016 Annual Report, April 1, 2016 through March 31, 2017. Pacific States Marine Fisheries Commission, Portland, Oregon.

Williams, S., E. Winther, C. M. Barr, and C. Miller. 2017. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River basin Northern Pikeminnow Sport Reward Program. 2017 Annual Report, April 1, 2017 through March 31, 2018. Pacific States Marine Fisheries Commission, Portland, Oregon.

Williams, S., E. Winther, C. Barr, and C. Miller. 2018. Report on the predation index, predator control fisheries, and program evaluation for the Columbia River basin Northern Pikeminnow Sport Reward Program. 2017 Annual Report, April 1, 2017 through March 31, 2018. Pacific States Marine Fisheries Commission, Portland, Oregon, Pacific States Marine Fisheries Commission, Portland, Oregon.

Winther, E., C. M. Barr, C. Miller, and C. Wheaton. 2019 Report on the predation index, predator control fisheries and program evaluation for the Columbia River basin Northern Pikeminnow Sport Reward Program. 2019 Annual Report, April 1, 2019 through March 31, 2020. Pacific States Marine Fisheries Commission, Portland, Oregon.

Wright, B. 2018. Pinniped Counts Astoria East Mooring Basin. Communication to J. Thompson (NMFS) from B. Wright (ODFW), RE: Sea lion counts update, 5/25/2018.

Yakama Nation Fisheries. 2019. Status and Trends Annual Report 2018.

YBFWRB (Yakima Basin Fish and Wildlife Recovery Board). 2009. 2009 Yakima steelhead recovery plan, extracted from the 2005 Yakima Subbasin salmon recovery plan with updates. Yakima Basin Fish & Wildlife Recovery Board. 288p.

YBFWRB (Yakima Basin Fish and Wildlife Recovery Board). 2015. Letter from Executive Director Alex Conley to NMFS West Coast Region: YBFWRB Input for the 2015 NOAA 5-year Review for the Middle Columbia River Steelhead DPS. May 7, 2015.

Zabel, R. W., M. D. Scheuerell, M. M. McClure, and J. G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1): 190-200, 2/1/2006.

NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW
Oncorhynchus mykiss: Middle Columbia R

Current Classification: Threatened

Recommendation resulting from the 5-Year Review

- [ ] Downlist to Threatened
- [ ] Uplist to Endangered
- [ ] Delist
- [x] No change is needed

Review Conducted By (Name and Office):

West Coast Region Middle Columbia River Steelhead DPS Evaluation Team

REGIONAL OFFICE APPROVAL:

Lead Regional Administrator, NOAA Fisheries

Approve Korie Ann Schaffer Date: 06/30/2022
For Scott M. Rumsey, Ph.D., Acting Regional Administrator

Cooperating Regional Administrator, NOAA Fisheries

[ ] Concur [ ] Do Not Concur [x] N/A

Signature__________ Date: _______

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

[x] Concur [ ] Do Not Concur

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July 26, 2022